Adopting design-led innovation: A study of integrating design practices into the innovation process of multinational science and technology-led firms

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PhD

2018

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A thesis submitted in partial fulfilment of the requirements of the University of Northumbria at Newcastle for the degree of Doctor of Philosophy.

Research undertaken in the Faculty of Arts, Design & Social Sciences.

April 2018

Abstract

Research has identified the beneficial impact that design-led innovation can have on the competitive success of organisations, however there has been a lack of supporting research that builds on this domain in order to identify areas of best practice for the initial integration of design-led innovation into organisational innovation practices. This study aims to fill this gap by investigating the way in which three multinational science and technology-led corporate organisations have attempted this integration. Data collection was guided by a case study approach and occurred in the form of embedded engagements leading to semi-structured interviews, with corporate staff across three in-depth cases.

The findings of the research have utilised the case study data to underpin the creation of a theoretical framework that is capable of explaining the way in which design-led innovation has been integrated across the three corporations. The framework demonstrates a cyclical relationship between organisational culture, strategy, structure and operations; in order to provide an explanation for the way in which design has been integrated based on the presence of various barriers to and enablers of design-led innovation.

The research findings have importance to business leaders, practicing design managers and academics. For business leaders and design managers, the work offers guidance for optimal practices to integrating design-led innovation, through both top-down and bottom-up approaches, supported by examples from the participating cases. In the case of design academics, the research furthers the theoretical understanding surrounding the way in which design-led innovation occurs, particularly with the creation of a dynamic framework, which differs from existing static approaches.

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Preface

In 2009 I began a Bachelors degree in Business with Economics at the University of Northumbria, Newcastle upon Tyne. At the time I had an expectation that this course would provide me with the foundation for a career in business, with role in management or marketing a likely career destination. Little deterred me from this expectation, until a final year strategy lecture introduced me to the concept of design-driven innovation. Up to this point, I had no previous knowledge of design as a discipline outside of stereotypical associations surrounding aesthetics and craft. The lecture itself discussed the role that design had played in shaping the strategic decision making of British Airways, developing a customer focused approach to develop new concepts for air travellers. At the time, this seemed radically different from traditional business strategy content and sparked a curiosity surrounding design practice that I have held ever since.

This newfound interest in the discipline of design led to my enrolment in MA Multidisciplinary Design Innovation (MDI), a course that aimed to bring together students from the disciplines of design, business and technology in order to work on live projects for organisations. Over the course of a year, I had the opportunity to work on social and corporate innovation projects for a range of clients ranging from multinational organisations, including Unilever and Akzo Nobel, to smaller organisations such as local councils. These projects provided me with a first-hand experience of the design-led innovation process, which was a way of solving strategic business problems that was far from what I had previously imagined. In particular, seeing the impact that design-led innovation was capable of having on the decision making process within multinational organisations cemented my interest in the subject area beyond the scope of the Masters programme.

Stemming from this curiosity, I embarked on the PhD process with an aim of exploring design further within the context of multinational organisations. Initially, the aim was to develop an understanding surrounding the competencies needed for successful design-led innovation, however over time, the focus of the study evolved and shifted towards the introduction of design-led innovation within multinational organisations that failed to maximise the potential of design outside of improving product aesthetics.

This thesis is ultimately a product of this journey, having developed my own understanding of design-led innovation whilst having the opportunity to research businesses as they do the same thing. The results of this endeavour are presented in this study and are my contribution to the academic debate. I sincerely hope that you will have as much pleasure reading this thesis as I did writing it.

Acknowledgements

This research would not have been possible without the support of the people and institutions who were involved in the PhD in various ways. Firstly, I am grateful to Northumbria University for proving me with a full scholarship and the necessary resources to undertake the doctoral research in a full-time capacity.

I would especially like to thank my supervisory team of Professor Robert Young and Dr Mersha Aftab for their support and encouragement as I have carried out this research. Their knowledge and guidance has been an invaluable source of inspiration, which has been key to my continued development both as a researcher and a person. I would also like to thank Mark Bailey, Dr Nick Spencer and Neil Smith who have continued to support and challenge me since my time as a student on MDI.

In addition, I would like to thank the three organisations that agreed to participate in the research project. I am especially appreciative to the people who generously took time out of their schedules to participate in the interview process, their input was crucial in the data collection stage of the work.

Thanks also goes to my fellow PhD students and research colleagues at Northumbria University, who have made this journey a pleasurable one. Special thanks in particular to Christopher Knott, Dr Emmanouil Chatzakis and Cyril Tjahja, who were all immensely helpful as I was putting together the final version of this thesis.

I would also like to thank family: Vivienne, Allan and Brian for their love and support over the past three years. Their continued belief has been a constant source of encouragement to me and this thesis would not have been possible without their help. Lastly, I would like to dedicate this thesis to the memory of my Grandma, Dorothy. It makes me immensely happy to think about how proud she would have been.

Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others. Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought and granted by the University Ethics Committee on 16th June 2016.

I declare that the word count of this thesis is 59,613.

Name: John James Gribbin

Signature:

Date: April 2018

Glossary and Abbreviations

To facilitate the reading of this thesis, this glossary has been created in order to provide a convenient location for the definitions and abbreviations of key terms that occur frequently throughout the main text.

Circular economy - An alternative to a traditional linear economy (make use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life (WRAP, 2017).

Design-led innovation - The union of design and strategy, leading to innovation (Wrigley, 2017).

Design as (an) approach - The process of design thinking and co-creation in order to generate new ideas in a collaborative way with other disciplines (Gardien and Gilsing, 2013).

Design as (an) outcome - The specific contribution that design makes to a business through value creation, delivering new experiences and identifying value and opportunity spaces (Gardien and Gilsing, 2013).

Design as (a) capability - The design community within an organisation, which exists in order to support the design approach and enable optimal design contributions (Gardien and Gilsing, 2013).

Design to differentiate - Utilising design to develop people-focused brand experiences and orchestrate brand touch points (Gardien and Gilsing, 2013).

Design delivery - Defining design processes in order to ensure that they are carried out effectively (Gardien and Gilsing, 2013).

Design strategy - Understanding where design should be utilised across the organisation and the impact that it has on business objectives (Gardien and Gilsing, 2013).

Design programming - Design having a demonstrable role within business activities (Gardien and Gilsing, 2013).

Knowledge Transfer Partnership (KTP) - A UK wide programme that aims to help businesses improve their competitiveness through the better use of knowledge,

technology and skills that reside within the UK Knowledge Base. Typically around 350 graduate jobs are created across the UK each year (Innovate UK, 2018).

List of abbreviations:

CAD - Computer Aided Design

CEO - Chief Executive Officer

CTO - Chief Technology Officer

DLI - Design-led Innovation

DMI - Design Management Institute

FMCG - Fast Moving Consumer Goods

ICT - Information and Communications Technology

KTP - Knowledge Transfer Partnership

R&D - Research and Development

SME - Small and Medium Sized Enterprise

(S)VP - (Senior) Vice President

1.0 Introduction

The first chapter of this thesis seeks to provide an insight into the way in which this study has developed over time. It will document the research context that inspired this doctoral inquiry, before outlining the aims, objectives and research questions that were developed throughout the research process.

This chapter will also offer an insight into the content of the thesis, including an indication of the findings and contribution to knowledge offered throughout the study, as well as an overview of the value of the work to various audiences. The structure of the thesis will also be presented, providing an insight into the forthcoming chapters.

1.1 Research context

According to the UK Design Council (2017, p.2), 'the pace of change in the digital, biological and technological worlds is creating significant disruption for business, work and people'. This disruption is a global issue, requiring consistent change and innovation for businesses, and thus economies, to remain competitive whilst achieving significant growth. In order to achieve the state of innovation necessary to maintain this competitiveness, organisations are increasingly utilising design and design-thinking in a prominent role during the strategic decision making process (Dorst, 2011).

Design management research has reflected this trend, with a multitude of research seeking to outline the business value that design is capable of offering to firms. Organisations, such as the Design Management Institute (2015), have carried out extensive research into the positive impact that design is capable of having on the financial performance of publicly traded organisations based in the United States. Similar research has been carried out across Europe (Kretzschmar, 2003, Uk Design Council, 2012), again with the intent of measuring the financial benefits afforded through the integration of design. Similarly, anecdotal evidence from organisations such as: Apple, Google, IBM, and Amazon have become positive examples of design and innovation excellence, recognising a need to offer breakthrough products and services as well as continuously reinventing their own business models (Chatzakis, 2015).

Predominantly, this research has attempted to underpin the value that design is capable of offering to businesses, perhaps as a response to challenges from management disciplines who lack understanding of the value design can offer, whilst being under pressure to utilise quantitative methods of decision making. This type of research certainly provides sufficient evidence to support the widespread use of design-led innovation (DLI) within organisational innovation practices, however there is

currently a lack of consensus as to how firms should ideally attempt integrating DLI. Buchanan (2004) describes this integration as one of the most important challenges within management today, however it is a difficult area in which to gain clarity. Not least, this is because there are a variety of methodologies available when attempting to integrate DLI (Ward *et al.*, 2009), with a current lack of understanding surrounding how these practices are embedded within organisations (Bucolo and Matthews, 2011b). In particular, there is a critical balance between barriers and enablers to DLI that changes over time as design is integrated within organisations.

The purpose of this thesis is to address this need for greater understanding surrounding the integration of DLI into organisational innovation practices, whilst finding appropriate ways to explain the fluidity of barriers and enablers over time.

1.2 Objectives, methodological approach and research implications

As outlined in Section 1.1, the initial objective of the thesis was to increase knowledge surrounding the mechanisms involved in the integration of DLI. The research set out to achieve this by developing this understanding within the context of multinational organisations, primarily influenced by the researcher's personal interest in the innovation practices of multinational firms as opposed to smaller enterprises. As the study progressed and conversations were had with potential case study organisations, it became apparent that science and technology-led organisations were most willing to engage with the research process. Ultimately this led to the further refinement of the focal area of study and the creation of the research question 'how do multinational science and technology-led organisations adopt design-led approaches to innovation?'

A full description of the research philosophy, strategy and design is provided in Chapter 4, however Table 1 provides a summary of the approaches utilised in order to answer this research question throughout the thesis.

Epistemology	Constructivism
Ontology	Relativism
Methodology	Case study research (Yin, 2012)
Phenomenon under study	The way in which organisations have attempted to integrate design-led innovation into their existing innovation practices.

The selected cases	Organisation A - A global engineering and manufacturing firm that specialises in exploiting industrial applications of its technologies. Organisation B - A global Fast Moving Consumer Goods company with a portfolio of over four hundred brands. Organisation C - A global engineering and manufacturing firm that specialises in the development of subsea equipment.
Data type	Qualitative
Data collection method	Semi-structured interviews, influenced by case study research protocol
Analytical method	A coding strategy that builds on the maturity framework of Philips Design (Gardien and Gilsing, 2013) in order to categorise the findings as barriers and enablers to design-led innovation in relation to *design as approach*, *design as outcome* and *design as capability*

Table 1 - Research design overview.

This process resulted in a data set that provides a theoretical framework for the introduction of DLI, which builds on the model of organisational culture outlined by Dauber *et al.* (2012). The original framework documents the dynamic relationship between organisational culture, strategy, structure and operations to explain the empirical complexity facing modern organisations. This thesis builds on this framework to demonstrate the dynamic relationship between barriers and enablers to DLI as it is introduced into the innovation practices of the three case studies.

The findings have implications for both research and practice and as such, should be of interest to both academic researchers and design leaders. In relation to academics, the work offers a theoretical understanding for the way in which barriers and enablers to DLI change over time as design is integrated into organisations, with a focus on the development of a mature culture for design. Similarly, the work offers practitioners an insight into the challenges that they will face in facilitating this integration within their own organisations. They will find out the challenges facing three multinational science and technology-led firms as they have carried out this integration, including a discussion of the ways in which these challenges have been overcome and an understanding of best practices that have emerged as a result.

1.3 Thesis structure

The thesis structure follows the process that was undertaken throughout the completion of the research and is organised into the following six chapters:

Chapter 2 and 3 - Literature review

These two chapters seek to underpin the theoretical implications for the research by undertaking a synthesis of findings from relevant literature. The first chapter seeks to provide an understanding of the term design, before exploring the way in which DLI is utilised within organisations. The second chapter builds on the preceding findings to discuss the notion of maturity within design research, both as a tool for identifying the business value of design and as a tool for explaining the integration of DLI.

Chapter 4 - Methodology

This chapter presents a detailed overview of the methodological considerations that informed the research process. The chapter begins with a discussion of relevant research philosophies, whilst also considering the position of the work in relation to the wider fields of design and management research. This is followed by a discussion of general methods within the two fields, before the identification of specific methods that are most suited to this research project; specifically case study research and semi-structured interviews.

Chapter 5 - Creation of a conceptual framework and analysis of data

This chapter describes the analysis process that was carried out upon completion of the data collection. It begins with the discussion of a relevant analysis framework that was identified in order to determine important variables from the data set. The application of the framework is then discussed, with a two-stage coding process then being used in order to analyse the findings.

Chapter 6 - Findings from case study activity

This chapter outlines the way in which design has been integrated across each of the three case studies. A narrative has been created based on the interview transcripts in order to present the reader with a chronological understanding of design activity within each case. The chapter also identifies cultural factors that underpin the operating environment specific to each case.

Chapter 7 - Discussion and interpretation of findings

The discussion chapter incorporates the findings from the case studies into a broader discussion surrounding the integration of DLI into science and technology-led organisations. The chapter begins with a discussion of a relevant model of organisational culture, which acts as an anchor for the next section of the chapter, which discusses the findings and their relationship to wider organisation theory.

Chapter 8 - Conclusion

Finally, the conclusion chapter outlines the implications that the research has for both theory and practice, before explicitly stating the contribution to knowledge. Limitations to the research approach and recommendations for future research are then considered.

2.0 Literature review

The introduction of the thesis outlined the intention of this research to explore the integration of DLI within multinational science and technology-focused organisations. In order to contribute to knowledge within this field, the literature review chapter aims to outline relevant literature that contributes to the theoretical framework of the study. The literature review section of the thesis is divided into two main chapters, Chapter 2.0 outlines the use of design within organisations before Chapter 3.0 then outlines the way in which DLI is currently measured across organisations.

In Chapter 2.0, a working definition of design is explored to provide suitable context for the work, before the use of design across organisations is considered, including a summary of research that demonstrates the business value offered by design integration. Then an overview of DLI is presented, culminating in a discussion of factors that underpin the integration of DLI within organisations.

Chapter 3.0 then builds on the foundations of Chapter 2.0, by describing the notion of maturity within design practice and begins with an overview of the concept of maturity across several streams of research. The focus then follows a discussion of maturity frameworks within design research as both tools that are capable of measuring design's capacity for generating business value and as tools that are capable of explaining the way in which design is integrated into organisational innovation practices. Examples are provided from various contexts including those rooted in academic literature and professional practice.

Chapter 3.0 will then conclude with an outline of current gaps within the literature that this research is positioned to address.

2.1 Understanding design within the context of the study

Within design research, the term design is renowned for being particularly difficult to define. Heskett (2002, p.5) notes that 'discussion of design is complicated by an initial problem presented by the word itself. Design has so many levels of meaning that it is itself a source of confusion'. In part, this confusion is due to the scope of the term expanding dramatically. According to Zurlo and Cautela (2014) the influence of design twenty years ago was primarily concerned with the industrial product; however in recent years links to the evolution of organised production systems, and social and cultural consumption market dynamics has meant that design has moved progressively from tangible objects to intangible offerings where the value to users is derived from multiple additional factors (*ibid.*). This is further highlighted by Dean (2016, p.21) who states that:

> *"If at the beginning of the twentieth century 'design' referred to the activities, objects, graphics and interiors produced by the modern design disciplines and professions - architecture, graphic, industrial and interior - today it refers to all of this and more. New types of design have emerged within, between, and in combination with, the traditional specialisations to bring forth a surging landscape of designs: enterprise design, instructional design, social design, network design, user experience design, climate design, sound design, business design, applied design, green design, universal design, and market design to name a few. As if by genetic mutation, design has inflated in scope beyond the confines of the aesthetic disciplines to encompass the non-aesthetic techniques, services, and organisations of other professions and every day practices as well."*

As the scope of design has expanded, so has inquiry into design practice. Design has been described as a reflexive practice (Schön, 1991), the creation of artefacts (Simon, 1996), a way of making sense of things (Krippendorff, 1989; Cross, 2006) as well as the creation of meaning (Verganti, 2009). The lack of a consistent definition of design within academic research is highlighted further by Ralph and Wand (2009), who go on to suggest that any theoretical or empirical work in which design is a construct should seek to have a clear understanding of the term to help ensure construct validity. To reach a clear understanding of design within this study, it is necessary to ground the definition within both the context of academic literature as well as the context of design within strategic level leadership[1].

Within academic literature, some of the difficulty in attributing a universal definition to the term design derives from the fact that the word design can be used as both a noun or a verb, although Friedman (2002) expresses that it is the verb form of the word that should take precedence over all other meanings. Thus in Friedman's eyes design should be seen as a process rather than an outcome. Buchanan (in: Ralph and Wand, 2009) offers an alternative definition, in which design is the human power to conceive, plan, and realise all of the products that serve human beings in the accomplishment of their individual or collective purposes. Archer (1979) proposes a similar definition, suggesting that in its most general sense, design is the area of human experience, skill and understanding that reflects man's concern with the appreciation and adaption in his surroundings in light of his material and spiritual needs. There are limitations to these definitions in that Buchanan arguably fails to specify a clear definition of the term

[1] Strategic management can be defined as 'the process of identifying, evaluating and implementing strategies in order to meet organisational objectives,' (Jeffs, 2008. p.13). For the purpose of this study, strategic level leadership refers to the people who are involved in driving the strategic management process.

‘products’, for example does this include the design of processes or services? Similarly, Archer’s definition implies that a person must have experience, skill and understanding to carry out the design process; however if Simon’s (1996, p.111) view of design is to be believed, in which he proposes that design is the process by which one ‘devises courses of actions aimed at changing existing situations into preferred ones’, then people with no prior design skill or experience are capable of carrying out the act of designing.

Across each of these definitions, there is an emerging theme of design as a process that aims to improve human situations. Simon (*ibid*.) also attempts to bridge the gap between definitions that focus on the creation of material artefacts and that focus on the design process by arguing that the intellectual activity involved in producing material artefacts is fundamentally the same as the activity involved in solving organisation problems, such as a person devising a new sales plan for a company. According to Michlewski (2006), due to its comprehensive nature, the definition offered by Simon represents the closest to ubiquity in the fields of both design research and mainstream management, which is the domain where this research is positioned. A similar definition can be found in The Cox Review of Creativity in Business (2005, p.2), which specifically defines design as:

> *“what links creativity and innovation. It shapes ideas to become practical and attractive propositions for users or customers. Design may be described as creativity deployed to a specific end,”*

where creativity is:

> “*the generation of new ideas - either new ways of looking at existing problems, or seeing new opportunities, perhaps by exploiting emerging technologies or changes in markets,”*

and innovation is described as:

> *“the successful exploitation of new ideas. It is the process that carries them through to new products, new services, new ways of running the business or even new ways of doing business.”*

This definition is perhaps the most relevant to this study, in particular because in that it builds on the broad arguments offered by Simon, yet it is specifically embedded within the context of design contributing to the innovation of organisations. Mathers (2015) expands on this definition by outlining further roles that design can have within organisations, which primarily consist of: framing, problem solving, form, function and

style. Mathers (*ibid.*) suggests that the weighting of each role within a particular organisation is dependent on where the organisation positions itself across a spectrum of design disciplines. Borja de Mozota (1998) echoes this concept of design, whilst also drawing parallels to the discipline of management, in which both are activities that revolve around problem-solving, being systematic, and coordinating efforts. The use of design as a problem solver is particularly pertinent when investigating the role that design plays within strategic level management and will be discussed further in the next section.

2.2 The use of design within organisations

"As traditional organisations begin to fail in the face of twenty-first century complexity, strategic design has come centre stage with leaders and indeed governments searching for new approaches to recognising, anticipating and tackling some of our most pressing problems" (Rusk, 2016, p.185).

Contemporary organisations face complex, open-ended challenges that require leaders to broaden their range of thinking to develop successful strategies that are capable of dealing with these changes (Stacey *et al.*, 2000). Coyne (2005) highlights that most of the problems facing organisations now fall under the domain of being 'wicked'; a term coined by Rittel (1967) to describe the type of social system problem that can be confusing and ill-formulated, with conflicting values between clients and decision makers. In dealing with these challenges, organisations are frequently turning to multidisciplinary collaborations due to the broader depths of knowledge, resources and perspectives that are capable of enhancing an organisation's innovation outputs (Reuveni and Vashdi, 2015). Design is often at the core of this process, with organisations looking to implement design thinking to deal with institutional difficulties in dealing with open, complex problem situations (Dorst, 2011). In particular, this is because the properties of wicked problems accurately reflect the problems that frequently confront designers in new situations (Buchanan, 1992).

Utilising design to solve these types of organisational wicked problem has led to the popularisation of the term 'design thinking', which Lockwood (2009, p.xi) defines as 'essentially a human-centred process that emphasises observation, collaboration, fast learning, visualisation of ideas, rapid concept prototyping and concurrent business analysis, which ultimately influences innovation and business strategy'. The concept of design thinking can be traced back to Simon (1955), however more recently the work of Brown (2008) has led to a resurgence of the term, particularly within the context of the management field. Brown (*ibid.*) suggests that design thinking is capable of leading innovation that goes beyond aesthetics and as a result, creates ideas that better meet consumer needs and desires. Subsequently, it is theorised that design thinking is

capable of transforming the way in which organisations develop products, services, processes and strategies; all of which are capable of creating new forms of value to organisations.

Martin (2009) highlights that there has been a surge in organisations seeking to implement design thinking methods due to the potential of adding business value, however the number of design-thinking organisations remains a small minority. Martin (*ibid.*) identifies that the organisations best equipped to develop design thinking into a competitive advantage are those that have the capabilities to balance the exploration of new knowledge (innovation) and the exploitation of existing knowledge (efficiency). It is suggested that typically, the larger a company, the less likely they are to consider design thinking methods as an approach to solving problems due to pressure from stakeholders who value reliability over validity. More recently, however, Kolko (2015) has identified that a shift is occurring towards utilising design thinking within larger organisations. This shift is focused on applying the principles of design to the way in which people work to create a design-centric culture within an organisation, which removes design from historical associations with aesthetics and craft and instead elevates the role of design towards imparting a set of principles to all, to help bring ideas to life (*ibid.*). This aligns with the thinking of Brown (2009) who finds that larger companies are better positioned to drive innovation from a consumer-centric perspective that allows them to exploit assets that they already possess: a larger customer base, recognised and trusted brands, experienced customer service and support systems, and wide distribution and supply chains.

Design management is also being used to drive and implement corporate strategic goals, through creating vision and orchestrating collaboration across disciplines to deliver value to stakeholders (Holland and Lam, 2014). Borja de Mozota (2006) identified that design thinking can be used within strategic management in four different ways:

- Design as a differentiator in creating unique business offerings.
- Design as an integrator to bring together an organisation's assets and capabilities to form new capabilities and possibly unique competitive advantages.
- Design as a transformational tool that is capable of opening up new opportunities.
- Design as a tool for improving financial performance and return on investment.

Within the context of driving strategic goals design is used as a tool to give form to products, processes, and systems as well as providing form to decision making through networked decision processes (Steinberg, 2010; Manzini, 2011; Rusk, 2016). Borja de Mozota (2003, p.142) further suggests that 'to manage design at a strategic level is to manage the contribution of design to the strategy formulation process: to define the

responsibility and leadership assigned to design and its contribution to the organisational culture, search for opportunities for design innovations, and multiply demonstrations of identity through design'.

2.3 The business value of design

The previous section highlighted that design is utilised in a variety of ways across different organisations, primarily with the goal of solving complex problems to add business value to an organisation. Despite its widespread use, the foundations of the design discipline are embedded with tacit knowledge and that can be difficult to isolate within the organisational context (Cross, 1984; Nonaka and Takeuchi, 195; Smith, 2001). As a result, it is difficult to benchmark or standardise the measurement of design in a way that contemporary organisations are familiar with (Design Management Institute, 2015). Subsequently it can be difficult to persuade sceptical members of the senior management team to integrate design at the strategic level, given the difficulty of quantifying tacit aspects of design. This has led to a series of research papers that have aimed to explicate the value that design offers to organisations when it is integrated across a variety of levels, in an attempt to affirm design's role as a source of providing competitive advantage.

Cooper and Press (1995) identify that design generates value in a number of ways, primarily through reducing manufacturing costs, improving quality and enhancing company image. Furthermore, design also reflects dominant social values with the discipline historically aligning itself with movements for progressive change. Factors such as the environmental impact of organisations and new methods of responding appropriately to demographic change are key points in understanding design's value to organisations. The commercial and social values of design are equally important in the changing conditions that employers find themselves operating within (*ibid.*). Furthermore, Cooper *et al.* (2016) find that capabilities in design are among the five most important sources of competitive advantage alongside quality of products and services, and relationship with clients, but ahead of capabilities in manufacturing. This reaffirms the importance of design as a means to create value and supports the growing interest in design across Europe during the last decade (*ibid*., p.20).

The Design Management Institute (2015) maintain a 'design value index', which aims to provide an up to date account of the financial performance of several design-focused organisations. The current iteration of the index tracks the performance of sixteen publicly trades stocks from companies that are considered to be design-centric based on a set of criteria reflecting best practices across design management. The selected companies demonstrate a 211% return over the Standard & Poor (S&P) 500 index, marking the third year in a row that the selected organisations have returned results in

excess of 200% over the S&P 500. This demonstrates the way in which publicly traded organisations placing a design strategy at the core of organisational innovation processes are outperforming competitors within the marketplace. Similar results have been found within Europe, where Kretzschmar (2003) highlights that Danish companies who purchase design have registered a total increase in their gross revenue over the past five financial years by approximately DKK 58 billion higher than that for companies who do not purchase design. Additionally companies that have experienced an increase in design activity achieve an additional 40% gross revenue increase compared to companies where design activity is either constant or has decreased (*ibid.*). Equally, in a study of UK SMEs, the UK Design Council (2012) find that for every £1 invested in design, businesses can expect to return over £20 in increased revenues.

At the macroeconomic level, studies have also taken the role of design into account when investigating the innovation capabilities of nations. The Cox Review (2005) concluded that strength in design at a national level is necessary for on-going economic sustainability and that currently many emerging economies are positioning themselves as sources of creativity and design. In a detailed study of design across several nations, the European Commission (2015) found that companies with at least 50 employees are the most likely to say that design is a central element in the company's strategy, whilst larger companies are also more likely to say that design is an integral but not a central element. Additionally older companies are less likely to claim that they utilise design at all, whilst the same can be said for companies whose turnover has fallen since 2012. Similarly, Moultrie and Livesey (2009) have created an international design scorecard that is capable of ranking nations based on several factors of design, namely enabling conditions, inputs, outputs and outcomes. The framework aimed to create a collective picture of national design capability in both absolute and relative terms. Interestingly, it is suggested that the US ranks highest in terms of absolute indicators of design capabilities, yet according to the European Commission study (2015) companies in the US are more likely to say that design is not used within the company at all when compared against similar organisations within the EU.

2.4 Design-led and design-driven innovation

According to Holland and Lam (2014), progressive companies across the public and private sector are learning to utilise design to inject fresh ideas into their activities, however the majority of organisations are still using design as a paradigm for adding artistic elements to products. Despite this, Section 2.2 highlighted that design thinking is becoming an essential part of successful business practice, with organisations seeking to become design-led to maintain or establish competitive advantage.

In order to become design-led, Bucolo and Mathews (2011a) suggest that cultural transformation needs to occur within a business to ensure that the necessary tools and approaches to enable design-thinking are successfully embedded. Furthermore, for a business to be design-led, it is necessary for the business to have a vision for top line growth that is based on deep customer insights and expanded through customer and stakeholder engagements (Wrigley, 2017). In order to assist organisations in becoming design-led, Figure 1 shows a conceptual framework developed by Bucolo *et al.* (2012), which aims to underpin the balance between operational and strategic activities. The framework demonstrates a cyclical relationship between three key phases: gathering customer insights to reveal latent needs, proposing future oriented solutions that capture value from these insights, and shaping strategy that leverages the value offered through future oriented propositions.

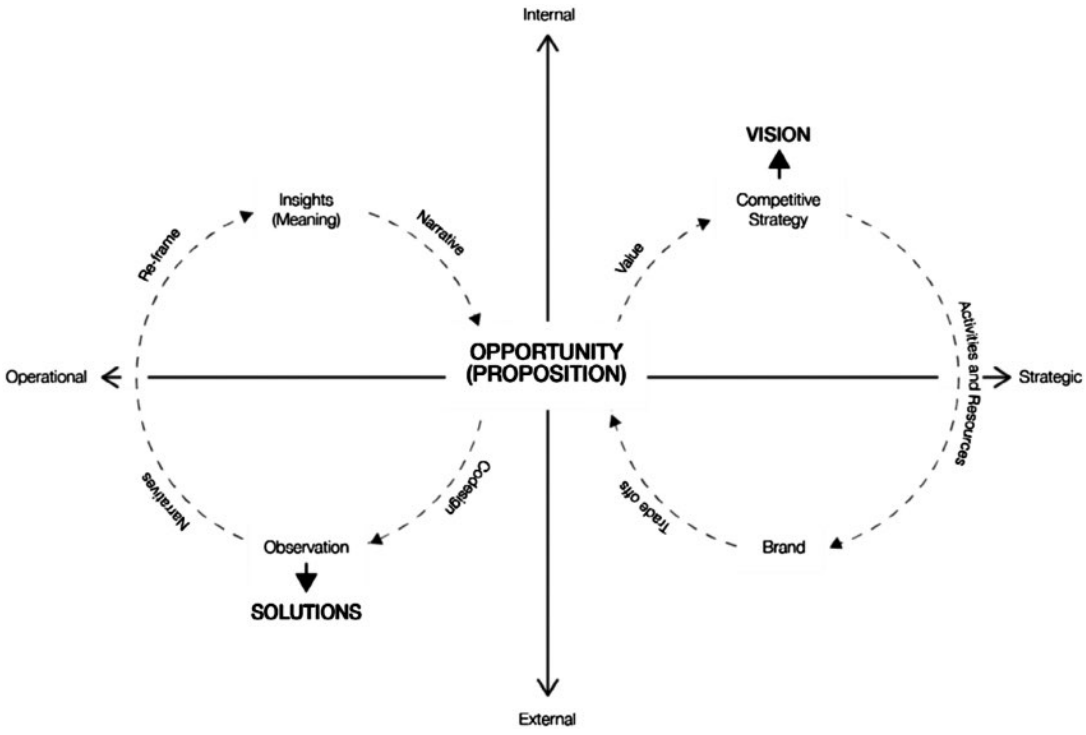

Figure 1: Design-led innovation framework (Bucolo *et al.,* 2012).

To achieve this status of being design-led, many organisations are utilising the techniques associated with design-driven innovation to broaden design thinking beyond user-centred design and balance knowledge of user needs with technological development and product language (Verganti and Öberg, 2013). Utilising design-driven innovation in this way offers organisations an opportunity to build a competitive advantage (Talke *et al*., 2009), in particular through product differentiation (Dell'era and Verganti, 2009). This aligns with the framework of Bucolo *et al.* (2012), who outline that being design-driven is critical in understanding who an organisation's customers are.

The theory of design-driven innovation has its roots in the work of Krippendorff (1989) who interprets design as a meaning-making activity. Recent theories of the knowledge economy, in particular, demonstrate that value is increasingly conveyed by the sense and meaning of things (Pine and Gilmore, 1999; Drucker, 2002). More recently, Verganti (2003; 2009) has sparked a shift in interest towards design-driven innovation, through the suggestion that organisations possessing strong innovation capabilities focus on the radical innovation of meanings as opposed to more traditional technology push or market pull innovation strategies. The theory postulates that people invest in the meanings behind products as much as they invest in the product themselves. Similarly, design plays an important role in incremental product innovation within organisations. This refers to the small changes in a product or service that help to improve performance, lower costs and enhance desirability to customers (Norman and Verganti, 2014). Most successful products undergo this process, which makes it a process that is equally important as radical innovation. It is the area in which the core of many businesses operate and often most revenues are generated.

De Goey *et al.* (2016b) identify an increase in design-driven innovation focussed literature since the publication of Verganti's (2003) initial discussion surrounding the innovation of product language and product meaning, which again surged surrounding the publication of Verganti's (2009) book on design-driven innovation. Design-driven innovation literature also spans several fields, with areas such as: product development (Cantarello *et al.*, 2011), marketing (Hakkio and Laaksonen, 1998), design management (Cautela and Zurlo, 2012), business model generation (Battistella *et al.*, 2012), service design (Beltagui *et al.*, 2012) all being the focus of published work.

According to Norman (2013) design expertise is responsible for discovering the needs of users that they cannot express by themselves. Emotion plays a fundamental part in this process as people feel more motivated connect with products when an emotional relationship is established through product aesthetics. Straker and Wrigley (2016) identify the role of emotion, experience and meaning as a potential reason for the disconnect in successfully implementing design-led approaches to innovation. They highlight Apple and Samsung as organisations that have successfully adopted a design-led approach to innovation, with Apple focusing on brand experience and creating an ecosystem of products that customers buy into and Samsung focusing on appealing to a wider audience through an array of strategic partnerships. Both of these companies exhibit different innovation types, however their ability to innovate stems from a clearly defined strategic process and a strong emotional reinforcement for that process.

Despite the interest in the perceived competitive advantages that stem from adopting design thinking or DLI within the strategic operation of organisations, Hill (2009, p4.)

notes that ‘company after company espouses the ruling orthodoxy that feelings are messy, dangerous, inferior and perhaps even irrelevant to day-to-day business. So to one degree or another we end up downplaying the fact that emotions are central to life and our business planning and outcomes suffer accordingly’. This line of thinking conflicts with the conditions necessary for design to take up a position within an organisation where it is capable of leading innovation. Aftab (2013) investigates design-driven innovation within the context of strategic level leadership and finds that in order for an organisation to develop propositions through design-driven innovation, the design function must be given equal influence alongside other core organisational functions as design cannot lead an organisation on its own. Consequently, for design to share leadership responsibilities with other disciplines, the organisation must recognise the impact that design can have on the organisation’s overall strategy. To achieve this, the company must have a vision for top-line growth that is based on customer insights, however there are several barriers and enablers to DLI that play a role in determining whether design is capable of achieving this strategic vision. The following two sections aim to outline some of these factors that are prominent within literature as both encouraging and inhibiting the introduction of DLI.

2.5 Factors that contribute to successful design-led innovation

It is clear that DLI is high on the agenda of management in organisations that are seeking to gain new approaches to adding business value and generating competitive advantage, however the successful implementation of this practice is something that organisations continue to find difficult (Kyffin and Gardien, 2009). This is demonstrated further by Nussbaum *et al.* (2005), who indicate that innovation has become essential to increasing top-line revenues in a number of global organisations, however 96% of all innovation attempts fail to beat targets for return on investment (based on a survey of senior executives carried out by innovation consultant Doblin Inc.). Furthermore, in a literature review of design-driven innovation, De Goey *et al.* (2016b) indicates that little is known about if and how a company could change its innovation strategy towards design-driven innovation.

Ravasi and Stigliani (2012) underpin design capabilities as an area of interest in beginning to understand the factors that contribute to the integration of successful DLI, as it is not currently clear to what extent successful companies share similar structures, processes, resources and people. In highlighting deficiencies in current studies, Ravasi and Stigliani (*ibid.*) determine that additional work is required to establish more precisely what drives the capacity to consistently deliver superior product design; it seems unlikely that a pure spending strategy will allow an organisation to equal Apple or Bang & Olufsen and additionally the observation of excellent outcome may only indicate whether an organisation has a superior capability or not rather than identifying

where the capability has originated or what it is made of. Within design-driven innovation, Verganti (2009) outlines that creating design-driven capabilities are difficult because they are not easy to buy or replace, however this ultimately means that they are inimitable and therefore a sustainable source of competitive advantage. Capabilities themselves are generally made up of complex patterns of cultural, relational, human and technological resources (Leonard−Barton, 1992), with certain research suggesting that effective competition is based on incremental innovation that exploits carefully developed capabilities (Hayes, 1985). The remainder of this section will outline some of the cultural, relational, human and technological resources that are frequently commented on as enablers of DLI.

2.5.1 The role of a design champion

Holland and Lam (2014, p.59) define a champion as 'a person dedicated and responsible for the promotion of strategic thinking behind an initiative or a project. For example, a product champion is responsible for a new product development, an innovation champion is responsible for innovation initiatives within an organisation, and a design champion is responsible for the promotion of and strategic thinking behind design activities/directions'. Govindarajan and Trimble (2010, p.77) note that innovation leaders themselves generally lack positional authority. They claim that:

> "*even the most skilled need help from more senior executives. They do not always get it. Senior executives are typically involved intimately with an innovation initiative in only the early stages, for example, in vetting the business plan. At this moment, when the funding decision is made, the difficult trade-off between innovation and ongoing operations, between the present and the future is most obvious. Senior executives want to make sure that they are comfortable that the bet they are making is good one for shareholders. After that, the innovation initiative usually looks tiny compared to the performance engine. Some senior executives naturally shift almost all their energies back to the core business, imagining that they can hand off all responsibility for the initiative to the innovation leader. This is unfortunate. In most cases, only a senior executive in the performance engine can mediate ongoing conflicts."*

Thus, Dumas and Mintzberg (1989) identify the importance of a design champion as a core way in which to manage the design process, with the role best taken up by a chief executive officer, however they highlight that other executives are also capable of taking on the role. Martin (2009) offers an example of a senior figure taking on the role of design champion within P&G, where chief executive officer A.G. Lafley viewed design-thinking as the trade off between innovation and efficiency that was necessary to 'pull P&G out of its downward spiral' (ibid. p.82). A design champion in such a senior

position made it possible to appoint the organisation's first ever vice president for design strategy and innovation with the goal of building P&G's design capability and act as the organisation's champion of design thinking. 'Within three years of Lafley's appointment as CEO, P&G was transformed from a mature company with slowing growth, eroding profits and moribund brands into a genuine growth company with profit growth of 15% per year. Thirteen of its top fifteen brands had increased their market share (*ibid.* p.102). Similar stories can be seen across other multinational organisations, with the position of chief design officer acting as an advocate for design at the senior level of organisations such as Apple, Philips, PepsiCo and Hyundai (Pallister, 2015).

Whilst highlighting the importance of a design champion, Dumas and Mintzberg (1989) highlight that a design champion may not be sufficient for the full realisation of design within an organisation. Rubenstein *et al*. (1976) share this viewpoint, finding that individuals play large (often informal) roles in the initiation, progress and outcome of particular projects; however many unsuccessful projects also have someone that takes up the role of champion. Thus, other factors are also critical in underpinning the success of design projects within organisations.

2.5.2 Creating a culture for design knowledge diffusion

According to Schein (1990, p.111), organisational culture is '(a) a pattern of basic assumptions, (b) invented, discovered, or developed by a given group, (c) as it learns to cope with its problems of external adaption and internal integration, (d) that has worked well enough to be considered valid and, therefore (e) is to be taught to new members as the (f) correct way to perceive, think, and feel in relation to chosen problems'. Hill *et al.* (2012) build on this definition to claim that organisational culture is therefore the acceptance, in either a tacit or formal way, or norms of specific behaviour by the members of an organisation.

Tushman and O'Reilly (1997) identify that organisational culture lies at the heart of innovation, whilst Martins and Terblanche (2003, p.68) note that the basic elements of culture influence creativity and innovation in two ways:

- Through a socialisation processes in organisations, individuals learn what behaviour is acceptable and how activities should function. Norms develop and are accepted and shared by individuals. In accordance with shared norms, individuals will make assumptions about whether creative and innovative behaviour forms part of the way in which the organisation operates (Louis, 1980; Chatman, 1991).
- The basic values, assumptions and beliefs become enacted in established forms of behaviours and activity and are reflected as structures, policy, practices,

management practices and procedures. These structures and so on impact directly on creativity in the workplace, for example by providing resource support to pursue the development of new ideas (Tesluk *et al*., 1997).

Alvesson (2002) challenges the relationship between culture and socialisation by arguing that the two cannot be separated due to the fact that they are inherently intertwined, thus culture is more of a prerequisite to socialisation. However, Pascale (1985) echoes the view that socialisation is at the heart of culture within organisations, indicating that socialisation is the systematic means by which firms bring new members into their culture. It 'encompasses the process of being made a member of a group, learning the ropes and being taught how one must communicate and interact to get things done' (*ibid*., p.3). Louis (1985) takes a similar approach, highlighting that meanings are largely tacit amongst members of a particular group and are passed on to new members through socially transmitted behaviour patterns.

The importance of the tacit transmission of culture through interaction shares similarities to the way in which design knowledge is integrated through socialisation. Nonaka and Takeuchi (1995) identify that knowledge generally is composed of two dimensions, tacit and explicit, based on the work of Polanyi (1958). 'The tacit dimension is based on experience, thinking and feelings in a specific context and is comprised of both cognitive and technical components' (Popadiuk and Choo, 2006, p. 306), whilst the explicit component is articulated, codified, and communicated using symbols (*ibid*., p.306). Much of the knowledge in design is tacit in nature (Pugh, 1990, Casakin, 2007, Cross, 2008), however the ways in which this knowledge could or can be made explicit by the practitioner is still inchoate. Nonaka and Takeuchi (1995) note that socialisation is the conversion of tacit knowledge to tacit knowledge elsewhere within the firm, whist the conversion of tacit knowledge to explicit knowledge occurs through the process of externalisation.

Aftab (2013) confirms that the explicit definition of aspects of design knowledge such as: processes, methods and tools for design is essential for design to gain and maintain a functional leadership role within an organisation. This involves making sure that every individual working within the innovation process is aware of what they are doing, in order to improve their design performance within problem solving; a process that Schön (1991) refers to as knowing-in-action. It is important to note that knowledge appears to develop through experience within design practice, where experiential knowledge becomes an important factor in underpinning the decisions made by practitioners. Novices tend to solve problems by attempting to represent and classify problems by their surface features, whereas experts represent them in terms of their underlying features (Chi *et al*., 1981). Robinson (2010) highlights that experts are at a great advantage in solving the types of complex problems that are facing organisations,

in that they have a richer store of relevant knowledge and the ability to conceptualise it in ways that enable them to perceive possible problem solutions. Voss (1989) further emphasises this view, indicating that good problem solving emerges from a person having a substantial knowledge base integrated with knowing how to apply that knowledge to a wider range of problem contexts. Furthermore, Smith (2001) identifies that organisations capable of recognising a wealth of tacit and explicit knowledge and utilising it to achieve goals have a major competitive advantage over firms who are not in the same position. Thus, socialisation becomes a key component in ensuring that tacit knowledge is transferred to new members of an organisation, in the same way that culture is traditionally understood.

2.5.3 Workspace design

In creating a successful innovation culture, Moultrie *et al.* (2007) note that organisation workspace design can play a critical role in reflecting a firm's strategic intentions towards innovation by providing a physical embodiment of their desired modes of working. Myerson and Ross (2003) note that modern office environments are relatively new phenomenon that date back little more than one hundred years and act as the physical setting for the necessary functions that support industry, business, and government; making the office one of the key societal landmarks of the 20th century. According to Myerson and Ross (1999), the consensus about the 20th century corporate workplace was breaking down, in that fixed, sterile, factory-floor office environments were unable to support the new styles of team-based knowledge-driven, community oriented working, nor the demands of an increasingly mobile and self-deterministic workforce. This is particular the case in organisations that support design, where modern design-thinking requires spaces that can facilitate increasing levels of multidisciplinary collaboration (Seidel and Fixson, 2013). From an architectural point of view, Duffy and Powell (1997) argue that it is possible to facilitate information sharing and creativity through creating flexible spaces, using of open plan offices, hot-desking, and bright and airy design.

In relation to design thinking, Brown (2009) notes that it is possible for design thinking to be embedded in the physical spaces of innovation as well as through teams and projects. Brown (*ibid*.) emphasises the use of specific project spaces that are large enough to accumulate the research materials, photographs, storyboards, concepts and prototypes that are generated over the course of a project, making these materials available at all times to encourage creative synthesis. From a broader perspective, Kelly and Littman (2001) claim that the workspace within IDEO not only reinforces the corporate values of the firm, it also supports innovative activity through the provision of appropriate resources, visualisation and model making facilities and the ability to reconfigure depending on specific projects.

Wagner and Watch (2017) find that trends in innovation towards a more collaborative and open approach have translated into flexible workspaces that are highly responsive in allowing people, in a range of group configurations, to decide what works best in a range of situations. Face-to-face communication is at the heart of this trend, with the process complicated by the imperative to communicate both tacit and highly complex information. Subsequently, architects are reconfiguring buildings to create interactive and sharable spaces that facilitate the intimacy achieved through face-to-face communication (*ibid.*). This is echoed by Salter and Gann (2003) who find that, within the context of engineering firms, designers are keen users of ICT tools however they largely rely on personal exchanges and visual communication for difficult parts of their work. The immediacy of sketching and face-to-face exchanges is a key part of how designers solve problems (Perlow, 1999), thus an environment which inhibits or fails to encourage collaboration in this way has the potential to negatively disrupt innovation processes. Therefore, just as a beneficial workspace environment can aid the innovation processes of an organisation, poor workspace design can be detrimental to the integration of design across an organisation.

2.5.4 Integration of design with other disciplines

The relationship between the disciplines of design and marketing is an area of interest, particularly within the context of multinational organisations in which marketing is typically one of the dominant functions in terms of decision making (Kotabe *et al.*, 2002). According to Cooper and Press (1995) very little has been written about design within marketing literature and when it has been mentioned, assessment of its relative value and contribution to marketing has varied. Bloch (1995) made a similar observation during the same year, however has more recently suggested that design research activity has grown considerably (Bloch, 2011). Despite the growth in research, there is still an imbalance of literature due to the fact that marketing academics are unfamiliar with the aesthetic and engineering issues that connect the two disciplines (*ibid*.). Luchs and Swan (2011) suggest that product design in particular has been treated with benign neglect within marketing research, which is particularly surprising given the importance of product design to one of the 'four P's'[2] essential to successful marketing. Bloch (2011) indicates that this is in part due to the varied definitions of design within the literature, leaving scholars and practitioners unable to make a judgement as to whether design is simply styling or the creation of much more. Given the prominence of this thinking within research, it is also likely that the thinking is conditioned during the initial educational process of upcoming marketeers.

[2] The concept of the marketing mix and the four P's of marketing - Price, Product, Place, Promotion - was introduced in the 1960's and was quickly established as the basic model of marketing (Grönroos, 1997).

The relationship between design and other organisational functions is under increasing scrutiny as multidisciplinary collaboration is at the heart of the application of design methods to a broad range of innovation challenges (Seidel and Fixson, 2013). Hansen and von Oetinger (2001) outline that leaders within the growing knowledge economy must freely share ideas and expertise across the company whilst being committed to firm performance, however they stress that the cultivation of these types of manager within the organisation must be approached carefully. Iansiti (1993) and Leonard-Barton (1995) both argue that in order to deal with these challenges, leaders must be 'T-Shaped' in that they will have a deep knowledge of one subject and broad experience of other subjects. Brown (2007) argues that T-Shaped individuals within the context of DLI are not to be confused with a 'jack of all trades', they have a core competency but can easily branch out. They possess curiosity, empathy and aren't afraid to ask why.

It is clear that multidisciplinary collaboration is a necessary condition for successful DLI, however this can lead to complications within larger organisations. Luo *et al.* (2006) discuss the notion of 'coopetition' in which there is a nature of both competition and collaboration (cooperation) present within cross functional relationships. Subsequently, managers need to be aware that whilst market knowledge transfers across organisational functions is extremely valuable, an internal nature of competition between leading disciplines can potentially disrupt the flow of knowledge (*ibid.*). This is particularly important when considering the use of design as a customer-centric tool that is capable of gathering insights, when the marketing function may see themselves as performing a similar task for the organisation. Cooper and Press (1995) emphasise this by highlighting the effect that design can have on each phase of the traditional marketing mix: price, product, place and promotion.

Furthermore, Borja de Mozota (2003, p.81) notes that:

> *"In theory, design and marketing share the same mind-set of developing an understanding of customer needs and the factors that influence those needs to establish healthy customer relationships. In practice, the relationship between design and marketing poses problems that spring from a reciprocal ignorance of the other profession: the designer working with the marketer on product specifications ignores other marketing responsibilities and expertise. The marketer views design as an output (a package or product), not a process."*

Subsequently the effective integration of the two functions would be necessary in order to avoid the 'coopetition' phenomenon and encourage the facilitation of successful knowledge transfer across organisational boundaries. 'T shaped' individuals can be

positioned at the centre of this integration as they understand how to navigate the existing dynamics that are present in multiple organisation functions.

2.6 Factors that inhibit successful design-led innovation

Just as there are multiple factors that encourage DLI practices within organisations, there are also several barriers that need to be considered. Barriers to innovation are an important topic within management literature, primarily due to the impact that innovation has on the competitiveness of organisations and economies. This is summarised by D'este (2012, p.482), who notes that:

> "*successful innovation depends on a firm combining a range of capabilities, including capacity to access finance, understanding market needs, recruiting high-skilled staff and establishing effective interactions with other actors. Innovating firms necessarily are forced to cope with most, if not all of these challenges. Some firms, however, are deterred from engagement in innovation because of the difficulties involved, and remain locked into established routines. Other firms try to innovate and invest in formal or informal research and development, but may fail in bringing new products or processes to market because they are unable to overcome these barriers."*

Many of these barriers are also applicable to the introduction of DLI into organisations, however DLI also faces its own set of barriers that are specific to the integration of the discipline. De Goey *et al.* (2016a) identify that these barriers could occur before, during or after the product development process. Fundamentally, these barriers are inherently linked to the factors that can facilitate the introduction of DLI across organisations, as outlined in Section 2.6. As important as their presence is for enabling design, their absence can be equally detrimental to the process of integration. The lack of a design champion, a culture that does not support knowledge diffusion, a workspace design that is not suited to design-led approaches to working and multidisciplinary conflicts are all factors that could inhibit the introduction of DLI into an organisation's innovation practices. The remainder of this section will consider additional barriers to DLI that are not centred on a lack of enablers.

2.6.1 Organisational leadership attitudes

Strategic decision makers within organisations often lack understanding surrounding the role that design can have in enhancing competitiveness, with a common viewpoint that considers design as a cost to a business as opposed to an activity capable of generating profits (Liu and De Bont, 2017). This aligns with the work of Boland and Collopy (2004), who find that managers and designers typically exhibit differing

attitudes towards project work. Based on a study of management practitioners during an architectural project, Boland and Collopy (*ibid.*) identified two distinct types of attitude, which were later termed the design attitude and the decision attitude. The design attitude is described as a unique mind-set and approach to problem solving that allows designers to shape inspiring and energising designs for products, services and processes that are both profitable and humanly satisfying. This attitude takes an approach to problem solving that believes it is fundamentally difficult to develop a good solution to a problem; however through the implementation of a rigorous design process, when a great solution is finally derived the decision about which solution to implement becomes arbitrary. The decision attitude contrasts this viewpoint and is said to be more prominent within management disciplines. It is associated with the underlying assumption that it is easy to generate solutions to a problem, however it is difficult to make a final choice amongst these solutions. In making these final choices, there is a prominent fear of risk, high costs and inefficiency; all of which underpin the decisions of managers when faced with implementing solutions to problems.

Michlewski (2015) finds that these attitudes play a critical role informing the culture of organisations, thus the extent to which design is capable of embedding itself within a firm is dependent on the extent to which these attitudes are embedded within the management structure. This is consistent with the work of Lester and Piore (2004), who argue that innovation requires individuals to have an interpretative mindset as opposed to an analytical one. These opposing attitudes offer an insight into leadership barriers, with an ingrained management attitude that places an awareness of risk, costs and failure at the forefront of the decision making process; which inherently conflicts with the design attitude surrounding the ability to make decisions based on a confidence in the design process. Leonard-Barton (1992) argues that these values are very difficult to change, therefore obsolete mental models may be preventing a firm from integrating DLI.

2.6.2 Organisational skill gaps

In addition to conflicts surrounding cultural attitudes, Bucolo *et al.* (2012) identify organisational leadership gaps as a key hurdle in reaching the stage where design is able to contribute to a strategic vision. Specifically, these leadership gaps have been identified in areas such as: engaging with customers, observation, problem framing and adapting mentalities. This is echoed by Brazier (2004), who finds that leaders can often have an interest in design practices, however they lack an understanding as to how they can effectively use professional design in support of their goals.

Equally the skill gap issue can also stem from the position of the design discipline, whereby designers can lack the multidisciplinary backgrounds necessary to work within

the structure of contemporary organisations. Liu and de Bont (2017) find that this is the case within China where there is a lack of design talent with more than one area of expertise, which is problematic as the Chinese economy is transitioning to a knowledge economy that is more demanding of multidisciplinary teams in order to understand the complexity of the problems organisations now face.

Calgren *et al.* (2016) find that a lack of skill is a difficult area to correct within the context of large organisations, particularly when attempting to educate other disciplines on when best to utilise design practices. Specifically, skills in areas such as visualisation through drawing and building prototypes were considered highly useful, but difficult to learn, and a barrier to daily use. Similarly, the iterative nature of design-thinking proved to be a barrier, with organisations making decisions based on deadlines as opposed to appropriately using iteration to arrive at a solution. Training and education in these areas has allowed other disciplines within the organisation to gain a greater understanding of the design process, however the primary barrier remained in place whereby individuals were still unsure of when to best utilise design practices (*ibid*.).

2.6.3 Difficulty in expressing the value of strategic design

Carlgen *et al.* (2016) also find that sceptical managers often ask for proof that design-thinking is capable of adding value to an organisation, which leads to pressure to justify the use of design-thinking in a short time frame. The microeconomic value of design-thinking can be difficult to quantify, particularly in organisations where the intention is to develop DLI as a tool for shaping the long-term strategic vision of the organisation (Bucolo *et al*., 2012). Important features of DLI such as the development of new knowledge are inherent to the application of design-thinking, however this is not a feature that is easily quantified (Elmquist, 2007). Furthermore, much of the knowledge associated with design processes is either tacit or implicit (Cross, 1984), or a combination of both (Smith, 2001). Young (2008) confirms that some aspects of design practice can be made explicit such as ‘craftsmanship and its strategy’ in the form of a design outcome, but this is not likely the case for other forms of tacit knowledge, which are both hard to understand as well as difficult to articulate explicitly.

2.7 Summary

This section began with a discussion of the term design and its usage within both design and management research. This was followed by an overview of the way in which design is utilised in contemporary organisations, with a focus on a shift in perceptions from design as a source of aesthetics and craft to a discipline that is capable of impacting business value at the strategic level of operations, through DLI.

Enablers and barriers to DLI were then discussed, identifying relevant factors for organisations seeking to integrate design into their innovation processes. The next chapter builds on this understanding to understand the way in which design is integrated into organisational innovation practices, through the lens of maturity frameworks.

3.0 Maturity of design practice in relation to strategic decision making

Much of the design management literature to date has a specific focus on highlighting the value that design can offer to organisations, perhaps in the hope that it can expand the use of design into new organisations and territories that have historically viewed design with a sense of scepticism. Organisations such as the Design Management Institute have placed a large focus on highlighting the value that design-led companies experience, producing yearly reports that analyse the performance of US companies committed to design as an integral part of their business strategy (Design Management Institute, 2015). As a result of an increase in understanding surrounding design's capability to offer strategic value, an emerging field of research is developing with a focus on understanding how organisations attempt to implement DLI within their existing processes in an effort to capitalise on the value that design is proven to offer. In pursuing any competitive edge (in this case design), Grant and Pennypacker (2006) highlight that modern enterprises need to approach improvement in a purposeful manner as they cannot afford to improve recklessly or randomly. Committing an organisation to improvement requires a thorough effort to understand where the organisation currently is and where the organisation needs to grow. This line of thinking has led to an increase in research studies situated within the area of maturity of design practice.

Generally, the term maturity can be defined as the state of being complete, perfect or ready (Simpson and Weiner, 1989). Lahrmann *et al.* (2011, p.177) state that maturity 'implies an evolutionary process in the demonstration of a specific ability or in the accomplishment of a target from an initial to a desired or normally occurring end stage'. Thus, within an organisational context the notion of maturity is indicated by the cumulative effect that capabilities and processes can have on organisational success[3]. Within design research, the term maturity is used as a measure to evaluate an organisation's existing capabilities and highlight areas for future development, typically demonstrated through the use of a maturity framework.

3.1 Maturity frameworks

Maturity frameworks are capable of representing the way in which organisational capabilities evolve in a stage-by-stage manner along an anticipated, desired or logical maturation path (Pöppelbuß and Röglinger, 2011). Early examples of maturity models

[3] Backes and Wolff (2016) demonstrate that the term maturity is also used within the context of literature that focuses on the evolution of product development, specifically within the product lifecycle. It should be recognised that the term maturity is used within the product lifecycle context, however this literature review will specifically focus on studies that utilise the term maturity within the context of strategic organisational development.

can be seen in the work of Maslow's (1954) hierarchy of human needs and Kuznets' (1965) theory of economic growth. Contemporary maturity frameworks are derived from the work of Humphrey (1987) and Paulk *et al.* (1993) who initially developed a process maturity framework that would be capable of assisting organisations with the task of improving their software processes. Since the inception of this work, maturity frameworks have been proposed in multiple domains outside of software engineering, including: product development (Mcgrath, 1996), innovation (Chiesa *et al.*, 1996), product reliability (Sander and Brombacher, 2000), higher education (Nelson *et al.*, 2014), user-centric product development (Jokela, 2004) and service design (Zwicker *et al.*, 2012).

In an article discussing the use of maturity models as a tool for assessing product development capability, Fraser *et al.*, (2002, p.226) compare a sample of frameworks that demonstrate a range of subject and architecture. They suggest that maturity frameworks typically share a number of common properties, consisting of: a number of levels (typically 3-6), a descriptor for each level, a generic description of the characteristics of each level as a whole, a number of dimensions or 'process areas', a number of activities for each process area, and a description of each activity as it might be performed at each maturity level. Pöppenlbuß and Rölinger (2011) further specify maturity frameworks into two distinct categories: descriptive and prescriptive. Descriptive frameworks are intended to promote assessment criteria for each maturity level and additional level of granularity (Gottschalk, 2009). Subsequently the measurement criteria in these frameworks should be precise, concise and clear to discriminate between levels. Conversely, in prescriptive frameworks, models need to include improvement measures for each maturity level and available level of granularity, in the form of best practices. Within design research maturity frameworks are typically descriptive in nature and are primarily utilised within two different contexts. The first seeks to highlight the value that strategic design offers to organisations, whilst the second seeks to demonstrate how the influence of design changes over time within an organisation.

3.2 The Danish Design Ladder

Seemingly, the most commonly used maturity framework within design research is the Danish Design Ladder, which was developed in 2001 as a tool capable of illustrating the various forms that design may take on within organisations and the impact that this has on the economic effects of design to individual firms (Danish Design Centre, 2015). The Danish Design Ladder (ibid.) suggests that organisations utilise design in one of four forms:

- Non-design - Design is an invisible part of, e.g., product development and the task is not handled by trained designers. The solution is driven by the involved participants' ideas about good function and aesthetic. The users' perspective plays little or no role in the process.
- Design as form giving - Design is viewed exclusively as the final form-giving stage, whether in relation to product development or graphic design. Many designers use the term 'styling' about this process. The task may be carried out by professional designers but is typically handled by people with other professional backgrounds.
- Design as process - Design is not a result but an approach that is integrated at an early stage in the development process. The solution is driven by the problem and the users and requires the involvement of a wide variety of skills and capacities, for example, process technicians, materials technicians, marketing experts and administrative staff.
- Design as strategy - The designer works with the company's owners/management to rethink the business concept completely or in part. Here, the key focus is on the design process in relation to the company's business visions and its desired business areas and future role in the value chain.

In relation to the four steps of the Design ladder, it is suggested that the higher up a company ranks, the greater the strategic importance that they attribute to design. The primary purpose of the Design Ladder was to be used in a national survey as a first step to assess the economic benefits of design to Denmark. The survey showed that between 1998 and 2003, Danish companies that purchased design services increased their growth revenue by an average of 22%, displaying significantly faster growth than the companies that hadn't (Melander, 2015). Furthermore, a 2016 iteration of the survey has indicated that out of 805 responding organisations: 40% classify themselves as non-design, 15% as using design as form-giving, 30% using design as a process and 13% using design as strategy (Danish Design Centre, 2015). Additionally, Kretzschmar (2003) applied the Design Ladder to a number of firms within Denmark, concluding that there was a correlation between an increase in export share of turnover and an increase in gross revenue in correspondence with the degree to which a comprehensive approach to design is adopted, particularly in relation to organisations that utilise design within the context of the upper two stages of the four step Design Ladder.

Despite the widespread use of the Danish Design Ladder, it has received some criticism. Doherty *et al.*, (2014) claim that the model itself is generic and non-industry specific, as well as not being a framework for integrating design since the model only measures integration outcomes at an operational level. It has also been criticised due to the use of the term 'non-design.' The description provided of non-design signifies that design is an invisible part of tasks such as product development and the task is not

handled by trained designers (Danish Design Centre, 2015). Solutions in this case are driven by the perspectives of participants who have their own ideas about good function and aesthetic without consulting the perspective of potential users throughout the process. According to Topalian (2005) all organisations, bar none, use design and that the introduction of new products, services or processes cannot occur without design. This position is broadly supported by Hunter (2014) who states that 'everything man-made has been designed, whether consciously or not'. Consequently, within this specific framework, this definition is inappropriate to the real life contexts of organisations as the creation of products and services requires skills across the spectrum of design. It is likely to be the case that these actions are carried out by people that are not necessarily proficient in design and are subsumed under other functions such as R&D, engineering and marketing. The use of design in this manner means that design is likely to be present in organisations, however it is not capable of being identified as a separate design function.

Subsequently, people are unlikely to identify with having design present within their organisation as it is subsumed within other organisational disciplines, a point echoed by Tether (2005) who suggests that the perceptions of businesses vary however design is typically associated with the specification and production of tangible goods and the promotion of these goods through packaging and other forms of communication. Consequently, service oriented firms are much less likely to perceive that they have a strong commitment to design. This is a common aspect in design research that seeks to understand the extent to which organisations use design, with the UK Design Council also publishing reports that claim European economies, such as the UK and Italy, have a significant proportion of their businesses not using design at all in their operations (Miller, 2016).

Despite these criticisms, the Design Ladder has been successfully applied in certain situations. Whicher *et al.* (2011) utilise the Design Ladder to examine the rate of return on investment from design. From this work, several challenges associated with evaluating design for the purpose of policy are identified: lack of definitions and parameters for the design discipline, absence of common measures that are available internationally, difficulties in isolating design's contribution to a specific context and unclear criteria for success in projects which use design. Furthermore, in measuring the design output of several Denmark based firms, Kretzschmar (2003) highlights that the Design Ladder is an appropriate tool for indexing the perceived value economic value that design offers as well as pinpointing the specific way in which design is positioned within organisations. What is less clear, however, is the steps that are necessary to transition between each stage of the ladder. Subsequently, studies have emerged that utilise the Design Ladder as a foundation for a wider framework that attempts to explain how organisations undergo this transition.

Doherty *et al.* (2014) utilised an action research methodology within the context of a manufacturing based SME to interrogate design at the strategic level of the organisation. They determined a range of intermediate stages within the Design Ladder that contribute to an organisation's progression towards design as strategy; in particular, several smaller stages were identified between design as styling, design as process and design as strategy. The smaller stages are presented as cultural milestones that need to be met for companies to progress, they include: design as thinking, design as value creation, design as intangible, design as relationships and design as management. Perhaps most importantly, these stepping stones identify the importance of creating a culture for design within organisations for the influence of design to grow. Indeed one of the primary conclusions from the research is that 'once the culture of a company understands the value that design can provide from a managerial level, it is well on its way towards integrating design at a strategic level and becoming holistically design led' (*ibid.* p.79).

Best *et al.* (2010) also note the importance of culture in a study of European based SMEs, identifying 'design management as culture' being the top stage in a four step hierarchy. Again it is proposed that the earliest stage is when a company does not utilise design management, with design management as project and design management as function making up the remaining stages. In order to understand the hierarchy, five different factors are outlined that can explain an organisation's maturity, they are: awareness of benefits, design management process, planning, design management expertise and design resources. This model also benefits from an increased explanation underpinning these factors, by providing descriptions to explain what each factor would look like at each of the four maturity levels. This is something that is missing from the original Design Ladder and its presence makes it easier to foresee the use of this framework as a prescriptive tool that can be used to guide organisations that are new to implementing design management. Again the primary purpose of the paper was to determine whether design makes a difference to the bottom-line of organisations, however in doing this it was able to remark on the way in which certain factors influenced overall perceptions of design and how this changed as maturity increased.

Bucolo (2016) further expands the Design Ladder framework, based on experience within SMEs, by adding two more stages to the initial ladder: design as organisational transformation and design as national competitive strategy. It is argued that these two additional steps 'allow for a more complete description of the way multiple layers of design can be deployed by organisations in completely new ways to ensure they remain competitive and prosperous' (*ibid.*, p.88). Bucolo (*ibid.*) believes that many companies who are seeking to embark on a design-led journey are at stage two of the

ladder, using design as form-giving, and this is where they often get stuck. Furthermore, companies often perceive the next step in the ladder to be out of reach, making the Design Ladder a difficult tool to utilise for prescriptive purposes. Pettigrew *et al.* (2016), build on Bucolo's (2016) extension to the Design Ladder to create one of the few frameworks that primarily focus on mapping the application of design within firms as opposed to the wealth of frameworks that aim to help firms measure the value or benefits of design thinking. Five levels of maturity are proposed ranging from no DLI to DLI being a key driver of radical transformation of the entire business. Furthermore, several DLI factors are identified to 'provide a finer level of discrimination and assessment with practical usability and relevance from an SME perspective' (*ibid.*, p. 14). These factors are:

- Customer understanding and insight
- Customer engagement and co-design
- Alignment of the organisation with design instincts
- Adoption of design-led innovation mind-set, culture and approach
- Competitiveness - commercial performance
- Competitiveness - human factors

The framework itself was validated through interviews with a selection of CEOs from SMEs, who found it useful for gauging the implementation process of adopting DLI, however its application within larger organisations is untested (*ibid.*).

3.3 Other maturity studies

Although the Danish Design Ladder is perhaps the most adapted maturity framework within design research, several others with a similar purpose have emerged in recent years.

3.3.1 Innovation capability maturity model

In relation to an organisation's innovation capabilities, Essmann and du Preez (2009) have produced a three dimensional maturity framework that considers capability maturity, innovation capability constructs and organisational constructs to create a maturity framework that is the result of refinement and two different iterations. The framework suggests that there are three fundamental areas of innovation capability (*ibid.*, p.385):

- Innovation process - the practices, procedures, activities etc. that take ideas and/or opportunities through to concepts, then through development and implementation and eventually to a stage of commercialisation and operation (which may include

continuous refinement and optimisation). Basically it refers to the complete innovation lifecycle.
- Knowledge and competency - the innovation process requires both specific and broad-based knowledge and competency, whether already within the organisation or still to be developed or acquired. Also included are the associated management requirements for knowledge, competencies as well as technology.
- Organisational support - the structures, resources, measures, infrastructure, strategy and policies, leadership, etc. necessary to support the process and knowledge and competency requirements for innovation.

The focus of the paper is on broader innovation capabilities as opposed to a specific focus on becoming design-led. Several studies have considered the framework with regards to developing aspects of design, including: product design (Lutters *et al.*, 2014), design innovation (Pettigrew *et al.*, 2016), and employee-driven innovation (Sørensen, 2015).

3.3.2 Design Management Institute maturity matrix

The work of the Design Management Institute (2015) to explicate the value that strategic design can offer to organisations includes a maturity framework as part of a wider series of studies that aim to: communicate the value of investment in design, assess the maturity of design in an organisation and benchmark the areas in which design adds value. The design maturity matrix in particular aims to provide a simple mapping tool that can be used to: understand the process maturity of the design organisation, create a common language for strategic discussions with cross functional peers, and align investments in design with business strategy (Westcott *et al.*, 2013). The framework consists of five specific maturity levels: initial, repeatable, defined, managed and optimised; and three specific applications: development and delivery, organisation and system and strategy. The framework has been utilised by Rae (2015) to highlight that retrofitting a mature company to include designers presents certain challenges that are different from, for example, adding capacity to an accounting or IT function, however the challenges highlighted are specific to cases in which design is implemented in a top down manner. Primarily, these challenges are focused on design leadership, with a mention of other factors such as integration into organisational processes and developing a model that allows consistent collaboration with other corporate functions.

3.3.3 Philips framework

Furthermore, Gardien and Gilsing (2013) propose a three stage maturity framework that was developed to explain the progression of design within Philips. The framework

suggests that there are three stages of maturity, where design is: (1) within function but in context, (2) integrated and aligned with other functions and (3) measurably impacting business results and other functions. The initial purpose of the framework was to act as a roadmap to provide the design teams with a specific model that could guide them towards maturity, offering specific guidance on how to integrate and develop the design function into an organisation (*ibid.*); thus, when the highest level of maturity is achieved, design is completely integrated alongside the organisation's leading functions.

The framework itself contains a set of three primary factors: design as process, design as strategy and design as capability with each of these factors split into a further three subcategories in order to provide a detailed overview of areas for best practice. They are defined as follows (*ibid.*, p.60):

- **Design as capability** describes the design community itself. Within Philips this means 500+ individuals in 18 locations, all practicing design and representing the customer in all aspects of the innovation process, with the expertise in foresighting, interaction design, people research, service design, product design, and communication design. The differentiators in this section define the level of skills and competence of design in Philips' business. They exist to enable and support the design approach (design as approach) and enable optimal delivery of design contributions (design as outcome).
- **Design as approach** is the process of design thinking and co-creation to generate new ideas in a collaborative way with other disciplines. Philips design is committed to achieving meaningful brand experiences using a process called High Design, a human-focused, multidisciplinary, and research-based approach that allows the seamless integration of design into business strategy. The differentiators on this level aim to describe the role of design to bridge vision with reality by envisioning where to go, defining what to do and doing it efficiently and effectively.
- **Design as outcome** is the specific contribution design makes to the business. It describes the specific contribution of design in value creation, initially through new experiences, value spaces, and opportunities, then by developing people-focused brand experiences and orchestrating brand touch points, and finally through simplifying and value engineering design solutions, portfolios, and the value chain.

It is argued that these roles of design then develop over three maturity levels, which show how designers within Philips and other companies can move toward a more deeply embedded and effective design strategy.

Although the model is based in professional practice, it is consistent with academic literature. In particular, the work of Wolff and Amaral (2008), which highlights that the

integration of design management in a company occurs with the approach, integration and intention of managers through three dimensions: process, competencies and strategy. Process refers to the relationship between the design team and its environment, competencies are about the way design is understood and done and strategy is directly connected to management, team subordination and strategic controls (Wolff *et al.*, 2016). Similarly, the framework also bears similarity to the innovation capability areas highlighted by Essmann and du Preez (2009) in Section 3.3.1 of this thesis.

3.3.4 Design capacity model

In an attempt to help paint a picture of the use of design in companies, The University of Southern Denmark have derived a design capacity model (2014) in order to provide a systematic overview of a company's potential for strengthening its innovative and competitive performance through design initiatives. The primary differentiator between the design capacity model and other related frameworks is that the design capacity model uses multiple dimensions in order to describe design practice within an organisation. There are five dimensions in total, which include: design awareness, the importance of design in internal processes, user's involvement, innovation drivers and design capabilities (*ibid*). Each of the five dimensions are then rated on individual scales that determine where design fits within the management practice of an organisation.

The model has three primary uses (*ibid*), first it can be utilised as a tool for identifying a company's design management practice and as a result, act as a benchmark tool to compare results across similar organisations. The tool can also be used as the focus of dialogue throughout consultations or development activities that are carried out across an organisation. Finally, the tool can be used for internal discussions in which a company is seeking to improve their use of design capacity over time. It must be stated that the model is representative of opinions of participants gathered through interviews, consultations or other contacts with an organisation. This means that perspectives of participants can skew the findings of the model depending on individual roles and understanding of design within an organisation.

3.4 Practice based frameworks

As the growth of maturity frameworks within design literature is increasing, so is the use of maturity frameworks within consulting groups and design houses. The frameworks themselves are comprehensive but not necessarily based on rigorous academic literature. Girling (2015) highlights that doubts about investing in design are evaporating yet methodologies on how to measure and improve its effectiveness are

non-existent. Subsequently, a Design Management Survey was created in order to 'help organisations evaluate their level of maturity, gain insights and devise strategies to strengthen the role and impact of design across the organisation' (*ibid.* p.1). It is suggested that design goes from an initial stage to: adopted, managed, integrated and driven; with empathy, mastery, character, performance and impact being the primary factors of importance. These factors appear to be derived from the firm's previous experience with clients; subsequently it is not a model that is substantiated through rigorous academic research.

Similarly, Planview (2013) offer a framework that aims to help product focused organisations increase three factors which are deemed to be important to an effective innovation programme: people, processes and tools. Interestingly, the Planview framework sits on the boundaries of the two types of framework that class maturity as a term within the product lifecycle and also frameworks that class maturity as a capability (Backes and Wolff, 2016). In contrast to the previous framework, Planview's proposal builds on the work of the *Capability Maturity Model* integration framework developed by Carnegie Mellon University (2002), which relates back to the earlier work of Paulk *et al.* (1993) within the field of software engineering; thus, it follows a similar five stage model. Similar to other studies, the application of the framework is focused on identifying at which stage an organisation is operating. It is proposed that high maturity companies have innovation embedded in their company cultures from the boardroom level to the individual contributor level across all functions and that it is essential to have a culture that embraces failure, learns from it and moves quickly. The framework's potential to be used in setting a strategic direction is also emphasised.

The primary intention of these frameworks is often to attract new clients as opposed to underpinning theory at the core of implementing DLI. Interestingly, this perspective has led to a suite of frameworks that are prescriptive in nature, as opposed to the descriptive studies that are common within academic literature. Unfortunately, as the aim of the frameworks is to attract clients, the frameworks themselves do not offer specific guidelines for firms that are seeking to improve their maturity of design practice, therefore they never really fulfil their potential as tools that can guide organisations through implementing DLI.

3.5 Summary

Design research into maturity frameworks is a relatively new field. It is apparent that maturity frameworks are being utilised to understand how people are using design, however many of the existing frameworks are static and are not utilised to document the transition of organisations, thus there is a lack of consensus as to how organisations transition to a state in which they are using DLI effectively at the strategic

level of operations. Many of the frameworks produced are general, leaving room for industry specific studies that can build on existing theory. Furthermore, there also appears to be an imbalance in frameworks, with many focusing on SMEs and not considering the application to larger or indeed multinational organisations. Additionally, few of the prescriptive frameworks have been validated through use in multiple organisations.

It is a difficult area in which to gain clarity, as highlighted by Ward *et al.* (2009), who note that when attempting to implement DLI, different design mentors bring different techniques, methodologies and flexible creative thinking to each context in which they work. Subsequently, Matthews and Bucolo (2011) have found that no single intervention can be linked to a specific company change across organisations. Bucolo and Matthews (2011a) go on to highlight that although there is a significant number of design tools available to organisations to assist them in a design-led transformation, it is not well understood how these practices are embedded. More recently, Backes and Wolff (2016) also highlight scope for future research that is capable of expanding on existing maturity frameworks to prescribe best practices for the evolution of design within companies. From the review of existing studies, it is clear that there is a need for consistency in studies that have potential to explicate some of these best practices, particularly in relation to larger organisations. It is also clear that bridging a gap between academic theory and professional practice should also be at the core of future work.

4.0 Research methodology

The previous chapter identified a gap in knowledge relating to the way in which the integration of DLI occurs within organisations. This chapter will outline how this research study will go about generating new knowledge in this space. It will first consider the philosophical considerations that underpinned the research strategy, outlining an ontology of relativism and epistemology of constructivism as theoretical anchors for the research; whilst also considering the position of the study in relation to the wider fields of design and management research.

Following this, the research approach is outlined with a discussion of relevant methodological choices that impacted the way in which the study was carried out. Specifically the chapter will outline why a case study approach has been chosen above other relevant methods, before considering the way in which the individual cases were selected as well as explaining how the data was collected consistently across multiple cases through the use of semi-structured interviews. The results of this process can be seen in Figure 2, which outlines the specific methodological choices that were made throughout this research.

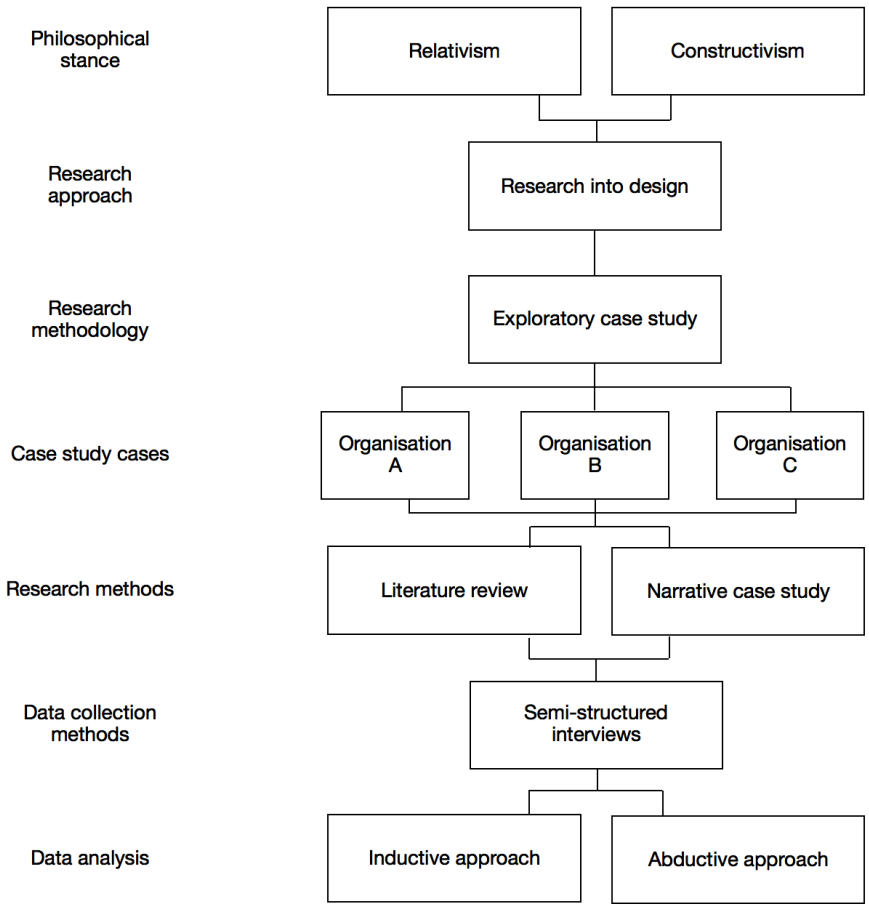

Figure 2: Methodology overview

4.1 Outlining the research question

Within academic research, the selection of an appropriate research methodology primarily stems from the nature of the initial research questions and the way in which these questions are interpreted by the researcher (Gill and Johnson, 2010). The literature review established that a variety of existing research demonstrates the benefits that organisations receive through utilising a design-led approach to innovation, particularly in regards to studies that utilise maturity frameworks. Despite this, there are relatively few studies that seek to understand the intricacies involved in the implementation of a design-led approach to innovation, particularly in relation to standardising a framework across multiple organisations that is capable of explicating methods of best practice when implementing DLI. This line of thinking has established a need for further research seeking to understand the way in which organisations develop DLI and in particular, whether a maturity framework approach can be adopted to identify common elements that impact the implementation of design across multiple cases.

The literature review also indicated that numerous studies considered maturity within the context of SMEs, however within larger firms the research appears to be skewed towards the perspective of practice as opposed to research. Subsequently, the initial intention of the study was to target multinational organisations in an attempt to bridge the gap between theory and practice. In approaching multinational organisations to be part of the study, it soon became apparent that the firms most willing to engage with the research had a strong historical foundation in either science or technology as key drivers of the innovation process. Thus, following further refinement, a focal research question of ‘how do multinational science and technology-led organisations adopt design-led approaches to innovation?’ was derived.

4.2 Philosophical stance of the research

This section will discuss a variety of philosophical issues that should be considered over the course of conducting research. Bryman (2012) outlines three key considerations that are necessary for researchers in the process of social research, they are: the nature of the relationship between theory and research, epistemological issues and ontological issues. These three areas provide a sound structure for the philosophical considerations of the thesis.

4.2.1 The nature of the relationship between theory and research

Bryman (2012) outlines two ways in which theory and research are related; there are instances in which pre-existing theory guides the research (known as the deductive

approach) and instances in which the theory is an outcome of research (known as the inductive approach). Furthermore, there is also an abductive approach to research, which is common within design research, in which design synthesis is fundamentally a way to apply abductive logic within the confines of a design problem (Coyne, 1988). Goel *et al.* (1997) explain that valid deductive arguments involve the claim that a premise provides absolute grounds for accepting a conclusion, whereas within the inductive reasoning approach a premise only provides limited grounds for accepting a conclusion. Inductive arguments are therefore intended to increase the probability of a conclusion turning out to be correct. Trochim (2006) simplifies this, suggesting that induction is moving from the specific to the general, whereas deduction begins with the general and moves towards the specific. Soiferman (2010) notes that deductive approaches to research are typically quantitative in nature, whereas inductive approaches are typically qualitative. Despite this, these two approaches are not mutually exclusive and can often be utilised in order to answer the same question through different approaches (Hyde, 2000).

According to Perry (1998), one of the most common variations of pure induction within research stems from grounded theory (Glaser and Strauss, 1967). Within grounded theory, a researcher will build a theoretical analysis through the collection of data and the creation of categories that explain what this data indicates (Charmaz and Smith, 2003). As a result, relationships between the categories begin to provide an insight into possible theoretical explanations for the data set. As a methodology, grounded theory has proven to be popular in both management and design research (Jones and Noble, 2007). Within the field of management, Locke (2001) attributes this popularity to the usefulness in developing new theory or fresh insights into old theory, providing theory of direct interest to practitioners, and an ability to uncover processes in complex unfolding scenarios. Interestingly, Mintzberg (1979) is assertive in his support of induction over deduction, claiming that organisation theory has suffered as a result of an obsession over rigour and statistically significant results. Similarly, within design research, Friedman (2003) suggests that grounded theory, and therefore induction, is a robust and sophisticated system for generating theories across all levels, however it must be developed from design practice in order to generate knowledge useful to the practice of the subject.

Deductive research is also extremely popular within management research. Johnson and Duberley (2000) attribute the popularity of deduction within management and organisation research to the paradigm of positivism underpinning a large number of studies; with deductive reasoning at the heart of this theoretical perspective. This can be seen in a number of studies that adopt the approach within a range of management subsections, as highlighted by Weele and Raaij (2014) and Oyegoke (2011). Deduction within design research is far less common, with Koskinen *et al.* (2011) noting that the

design process is inherently inductive and arguments that design follows the principles of logical deduction are largely contested throughout history. This is particularly pertinent in instances where designers creatively adapt methodologies in order to apply them to new problem situations.

Missing from Bryman's initial comments on the relationship between theory and research is the approach of abduction. The term abduction is used in two different formats throughout philosophical literature. According to the Stanford Encyclopaedia of Philosophy (2017) abduction can refer to the place of explanatory reasoning in *generating* hypotheses, as well as referring to explanatory reasoning in *justifying* hypotheses. In the latter sense, abduction is also often called Inference to the Best Explanation (*ibid*.). Discoveries across a range of social research can be traced back to the modern form of abduction and it is utilised by educationists, linguists, psychologists, theologians, criminologists, and other social scientists including designers (Reichertz, 2004). Kolko (2010, p.20) thinks of abduction as the 'argument to the best explanation', in that it is the hypothesis that makes the most sense given observed phenomenon or data based on prior experience. Kolko (*Ibid.*) has established that design synthesis is an 'abductive sense making process of manipulating, organising, pruning, and filtering data in the context of a design problem, in an effort to produce information and knowledge'. Thus abductive reasoning is particularly prominent in work that utilises a research through design approach to solving problems.

Richards (1993) notes that it is extremely unlikely for a piece of research to only follow one logical approach, given that prior theory and theory emerging from a dataset are always involved simultaneously. Thus, a combination of approaches is often utilised in order to solve modern research problems. Dewey (1997) and Gray (2014) echo this, illustrating the relationship between inductive and deductive reasoning within research problems. This study primarily adopts inductive and abductive reasoning at various stages. Inductive reasoning was particularly prevalent in the analysis of data, in which conclusions are derived from the observation of cases (Camerer, 1985). The analysis process involved detailed readings of raw data to derive concepts, themes, or a model through interpretations made by the researcher (Thomas, 2006). The analysis of the data also required an understanding of the activities conducted in implementing design-led approaches to innovation across multiple cases, informed by knowledge of individual interpretations of each situation. This approach is again consistent with inductive reasoning (Bloor, 1978). Abductive reasoning was more prominent in arriving at theory towards the end of the study, by ensuring all theoretical explanations for the data were considered, before the most plausible explanation was drawn (Charmaz, 2006). Thus, abduction was utilised as a means for enabling the researcher to discern connections that are not otherwise evident, forming new ideas and seeing things in different contexts (Meyer and Lunnay, 2013).

4.2.2 Epistemological and ontological issues

According to Bryman (2012), epistemological issues are those to do with what is regarded as appropriate knowledge about the social world, with one of the most prevailing questions being whether or not a natural science model of the research process is suitable for the study of the social world. Additionally, Bryman (2012) defines ontological issues as those that focus on whether the social world is regarded as something external to social actors or as something that people are within the process of fashioning. This research adopts a constructivist epistemology that is based on a relativist ontology (Guba and Lincoln, 1989).

Within social science research, the term constructivism is often used interchangeably with the term constructionism (Bryman, 2012) and is also talked about from an ontological perspective as well as an epistemology perspective (Nightingale and Cromby, 2002). Crotty (1998) identifies that within constructivism, social phenomena develop in particular social contexts. Practices within a particular context are actually artefacts of that context, with individuals and groups implicit in the creation of their perceived social reality (*ibid.*). Constructivism is often attributed to Piaget (1980, p.23) who states the following:

> "*Fifty years of experience have taught us that knowledge does not result from a mere recording of observations without a structuring activity on the part of the subject. Nor do any priori or innate cognitive structures exist in man; the functioning intelligence alone is hereditary and creates structures only through an organisation of successive actions performed on objects. Consequently an epistemology conforming to the data of psychogenesis could be neither empiricist nor preformationist, but could only consist of a constructivism."*

As a result, constructivism is a paradigm based on a reality that is socially constructed and given meaning by the people that are involved within its construction, as opposed to being created by the researcher themselves. Schön (1991) advocates the use of a constructivist philosophy within the design discourse, stemming from a belief that design activities are frequently based on intuition, thinking and experience, grounded within reflective practice. Equally, constructivism has been utilised to frame studies which focus on social science research within organisations, where the research findings are related to individual views of the world and create a world full of multiple constructed realities (Sobh and Perry, 2006). In following this philosophy, methodologies adopted within constructivist studies are typically qualitative in nature, with methods such as: interviews, observations, document reviews and visual data analysis all proving to be common (Silverman, 2000). Other research paradigms favour

different approaches with positivist knowledge preferring quantitative methods or closed-ended questions in order to verify theories (Andrew *et al.*, 2011).

Guba and Lincoln (1989) note that the constructivist paradigm is based on a relativist ontology. According to Westacott (2017) relativism is identified as the thesis that all points of view are equally valid. Typically the relativist viewpoint asserts that knowledge is relative to some particular framework or standpoint, for example the individual subject, a culture, or a language (*ibid.*). Crotty (1998) notes that constructivism leads to the viewpoint that the 'way things really are' is just the 'sense we make of them'. Subsequently, historical and cultural comparisons have resulted in divergent interpretations of the same phenomena. Thus relativism is the notion that different people may inhabit different worlds, which constitutes for diverse ways of knowing (*ibid.*). As a result, when something is described using the relativist paradigm, it is a case of reporting how something is seen and reacted to, and thereby meaningfully constructed, within a given community or set of communities (*ibid.*, p.64). Fundamentally, these philosophies adopt the viewpoint that individuals perceive their own realities and it is this viewpoint that has underpinned the collection of data within this thesis, leading to an appreciation that the context in which data is collected is as important as the data itself.

For the purpose of this research, the constructivist paradigm has been utilised with the participating organisations treated at a distance. The way in which data was collected is specifically outlined in section 4.6, however the researcher was outside of the organisation in the case of Organisation A and inside but not a direct participant within Organisations B and C. As this is the case, the organisations were not treated as part of the data being constructed. Instead the interview data helped to construct knowledge of design's integration across each case.

4.3 Design discourse

Within the context of multiple research paradigms, Cross (2007) claims that design is a discipline in its own right, based on the view that design has its own things to know and its own ways of knowing them. Over time, design research has emerged as a separate activity from design practice because of a growing need to understand the complexity of the systems that designers were being asked to create (Bayazit, 2004). 'The design methods movement grew out of this need, and generated the first cohort of design researchers focusing on the development of knowledge instead of artefacts for consumption' (Zimmerman *et al.*, 2007, p.3). According to Cross (2001), the design methods movement of the 1960s embraced strong aspirations to 'scientise' design, which marked the inception of design methodology as a subject or field of enquiry. The desire to scientise design culminated with Simon's (1969) work in which he called for

the development of a ‘science of design’ within universities that would create a body of intellectually tough, analytic, partly formalisable, partly empirical, teachable doctrine about the design process. Over time however, authors began to disassociate with the design methods movement. In particular, Alexander (1964) and Jones (1991) were critical due to a lack of success in the application of scientific methods to design practice. This was particularly relevant in relation to the work of Rittel and Webber (1973) who noted that scientific approaches were not appropriate when dealing with the wicked problems that designers faced.

The complexity surrounding design research in relation to other research paradigms has led several authors to address the relationship between research and practice, which has become particularly influential in the creation of a suitable research paradigm within academic design research. Frayling (1993) was one of the first authors to consider this relationship within design, adapting Herbert Read’s model of education through art in order to describe different ways of thinking about design research. Frayling (*ibid.*) offers a practical solution in framing types of design research by suggesting that studies typically fall into one of three categories: research into art and design, research through art and design, and research for art and design. Research into art and design is described as the most common occurrence and includes historical research, aesthetic or perceptual research, as well as research into a variety of theoretical perspectives on art and design (such as social, economic, political, ethical, cultural, etc.). Research through art and design accounts for the next largest category of research, which is comprised of studies utilising techniques such as materials research, development work or action research. The output of this type of research is typically in the form of a specific project declared in advance of carrying out the research. Finally, research for art and design is described as the most difficult type of research to define, where the end product is often an artefact. The artefact is said to embody the thinking of the research and the initial goal is not primarily communicable knowledge in the sense of verbal communication, but in the sense of visual or iconic or imagistic communication. The notion of three distinct research paradigms (into, for and through) is common within the design field, with other authors also taking this approach (Archer, 1995; Dickson, 2002; Rust *et al.*, 2007).

The three dimensions of design research are appropriate as a general overview of design research, however the definitions have been described as ‘too coarse, general and imprecise to be useful for a discussion about the detailed theoretical and methodological implications these types of research may have’ (Sevaldson, 2010, p. 12). Furthermore, Jonas (2007) critiques the typology with a particular focus on the superficiality of the definitions and the inconsistency in which the models are applied. For example, Friedman (2003) discusses ‘research by design’ in relation to the work of Frayling, however Frayling actually introduces the concept of ‘research through art and

design'. Similarly, Findeli (1998) utilises the term 'research through design', however Findeli's interpretation of 'through' differs to that of Frayling. Subsequently, more clarification in the area is necessary in order to overcome these inconsistencies.

Interestingly, Glanville (1999, pp. 88-89) argues that scientific research is a design activity in that 'we design experiments, but we must also act as designers in how we act in these experiments. We design the experiences and objects we find through experiment by finding commonalities (simplification): and we design how we assemble them in patterns (explanatory principles, theories). Looking at these patterns, we make further patterns from them - the theories of our theories. Thus, in doing science, we learn'. This is supported by Steinø and Markussen (2011), who argue that the design process and the research process are inherently similar, sharing an overlap in the knowledge, skills and competencies required to be a good designer and a good design researcher.

> "*While design is the act of creating new artefacts, research is the act of creating new knowledge. Research is therefore itself a design process. And just as design is a dialectic process of action and reflection, so is research. Hence, the main difference between design and research is the object; design creates artefacts (physical or abstract) and research creates knowledge."* (*ibid.*, pp. 4-5*).*

Thus, in the eyes of Steinø and Markussen (*ibid.*), traditional research is already an act of design. Subsequently they propose that design research is defined by the object of study, which falls into one of four categories:

1. Design research that deals with ontological questions of what design is and what is it good for.
2. Design research that deals with epistemological questions of how we can know about design and how we perform design.
3. Design research that deals with contextual questions of how design interacts with the world when it meets people, cultures, social systems, the environment, etc.
4. Design research that deals with procedural questions of which tools, techniques, and procedures that are relevant to the execution of design.

In this particular study, the research is primarily addressing contextual questions and to a smaller extent epistemological questions; considering how we can know about design, and how it interacts with the world within the context of organisational structures. This aligns with the constructivist philosophy of the study, in which the interaction of design within organisational structures is viewed through the viewpoint of the people that are present within the organisations. Additionally, the research identifies

with the research into art and design proposition offered by Frayling (1993), in which design is studied from an outside perspective within the context of organisations.

4.4 An outline of methods that were considered as part of the research

This section will aim to broadly outline relevant methodologies in both design and management research that were considered to be relevant when setting up the research. An outline of the selected methodologies that are part of the final study design will be presented in Sections 4.5 and 4.6. Blaxter *et al,* (2010) offer a useful taxonomy for framing discussions surrounding research design, indicating that methodologies contain three successive levels: two research families or general strategies for doing research, four approaches to designing a research project, and four techniques for collecting data. The taxonomy is outlined in Table 2.

Research families	Research approaches	Research techniques
Quantitative or qualitative	Action research	Documents
Deskwork or fieldwork	Case studies	Interviews
	Experiments	Observation
	Surveys	Questionnaires

Table 2: Research families, approaches and techniques.

Based on the taxonomy outlined in Table 2 and the multidisciplinary nature of the research, a number of strategies were available in collecting the data for the study. In order to understand the variance in approaches utilised within similar research projects, Table 3 presents a summary of adopted methodologies within several studies that made up the literature review, spanning the fields of design, innovation and management. Articles in more than one category occur when multiple methods were used as part of a single study, particularly in instances where approaches and techniques are specified.

Method	Studies
Semi-structured interviews	Pettigrew *et al.*, 2016; Hakkio and Laaksonen, 1998; Cautela and Zurlo, 2012; Connelly *et al.*, 2000; Burke and Collins, 2005; Miller and Moultrie, 2013; Røise *et al.*, 2014; Han and Bromilow, 2010; Michlewski, 2008; Gray, 2014.
Action research	Doherty *et al.*, 2014; Bucolo, 2016; Cautela and Zurlo, 2012; Bucolo *et al.*, 2012.

Survey/Questionnaire	Danish Design Centre, 2015; Kretzschmar, 2003; Melander, 2015; Best *et al.*, 2010; Essman and du Perez, 2009; Reuveni and Vashdi, 2015; Seidel and Fixson, 2013; Mumford *et al.*, 2007; Kiernan and Ledwith, 2014; Gray, 2014; Kovačević, 2008; Ananiadou and Claro, 2009.
Deskwork	Talke *et al.*, 2009; Moultrie and Livesey, 2009; Whicher *et al.*, 2011.
Case study	Essman and du Perez, 2009; Sørensen, 2015; Gardien and Gilsing, 2013; Wolff and Amaral, 2008; Dell'Era and Verganti, 2009; Cantarello *et al.*, 2011; Cautela and Zurlo, 2012; Battistella *et al.*, 2012; Starter and Wrigley, 2016; Kotabe *et al.*, 2002; Seidel and Fixson, 2013.
Literature review/ Theoretical papers	Kimbell, 2011; Smith, 2001; Design Management Institute, 2015; Rae, 2015; Wolff *et al.*, 2016; Wolff and Amaral, 2008; Lutters *et al.*, 2014; De Goey, 2016; Battistella *et al.*, 2012; Beltagui *et al.*, 2012; Ravasi and Stigliani, 2012; Martins and Terblanche, 2003; Moultrie *et al.*, 2007.
Observation	Rubenstein *et al.*, 1976.

Table 3: An overview of methodologies adopted within similar studies.

Table 3 demonstrates that a range of methods are being utilised across the fields of design, management and innovation. A literature review is one of the most commonly used methods within publications, highlighting the importance of a strong theoretical foundation to work in the field. This was carried out within Chapters 2.0 and 3.0 of the thesis in order to underpin the work within the context of a wide set of research, which ultimately narrowed to a discussion of the use of maturity frameworks within design management as a tool for understanding DLI within organisations. Section 4.5 outlines the approach to reviewing literature that was adopted for this study.

Furthermore, it is clear from Table 3 that the majority of research in the field favours a qualitative foundation with few studies embracing quantitative methods as the primary method of data collection. A wide spread in research can be seen in terms of the research approaches that are being utilised with action research, case studies and surveys all being utilised within the field. Interestingly none of the papers reviewed utilised experiments. Crouch and Pearce (2012, p.143) discuss the use of action research within design, identifying it as 'perhaps the most powerful and liberating form of research available to practicing designers'. Crouch and Pearce (*ibid.*) note that there is a close connection between the philosophy of action research and the notion of praxis since within action research the connections between thought and action, particularly in professional contexts, become central to the research process. Unsurprisingly, action research is popular amongst studies in which the researcher is embedded within an organisation and utilising design methods in order to improve the design practice of organisations. Accordingly, Swann (2002) notes that action research is particularly appropriate to design research in instances where the final outcome of a

project is undefined, because of its inherent flexibility and openness. Subsequently action research is common amongst those utilising a research through design approach as it is conducted within practice (Kemmis and Mctaggart, 2003).

Similarly, case studies have been utilised in instances where the researcher is less influential on the final outcome of a project. A range of single and multiple cases are presented within the literature, with single case designs reflecting unique or extreme cases within the field of research, as seen in the work of Sørensen (2015). A single exploratory case design allows the researcher to pursue the research questions with a focus on the deeper internal and cultural phenomena of a case (Yin, 2014), however it makes it difficult to generalise the conclusions across multiple organisations (*ibid.*). Alternatively, a multiple case design is beneficial in ensuring that the findings in a particular study can be replicated (Yin, 2014), which allows the analysis of cases to be treated as a series of independent experiments (Brown and Eisenhardt, 1997).

Further variance can be seen in the range of specific techniques that have been utilised across the literature, however semi-structured interviews were one of the more popular choices in this domain. This is perhaps to be expected, as according to Holloway and Wheeler (2010), semi-structured interviews are the most common type of interviews utilised within qualitative research. Semi-structured interviews combine specific questions in order to bring forth the foreseen information and open-ended questions in order to elicit unexpected types of information from the participants (Hove and Anda, 2005). The flexibility of the method is one of its primary advantages, in that it allows researchers the opportunity to explore issues that arise spontaneously yet keep focused on the initial research question through a series or predetermined questions (Berg, 2009). Similarly, higher participation rates may have also factored into the popularity of studies utilising semi-structured interviews within design research, with several authors noting that the response rate of semi-structured interviews is particularly high, especially when compared to surveys in which participants may not have the confidence to write down responses (Kidder and Selltiz, 1981; Bailey, 1987; Louise-Barribal and While, 1994).

Taking the variety of research designs and approaches into account, alongside a search for further methods, two research strategies initially appeared to be particularly relevant in acquiring the data necessary to answer the focal research question. They can be categorised as participant observation and repertory grid interviews.

4.4.1 Participant Observation

Through an action research approach, participant observation is ‘a method in which a researcher takes part in the daily activities, rituals, interactions, and events of a group

of people as one of the means of learning the explicit and tacit aspects of their life routines and their culture' (Dewalt and Dewalt, 2011, p.1). Participant observation allows a deep understanding of the tacit aspects of a situation, which allows a researcher to understand nonverbal communication, and anticipate and understand responses. This shapes interactions with others and, more fundamentally, shapes the interpretation of the data (*ibid.*). More recently this type of research, within the domain of design, has fallen at the intersection of ethnography, participatory action research and socially responsive instructional design (Barab *et al.*, 2004).

In the early stages of the research project, participant observation appeared to be the most suitable research strategy for the study. The intention of the researcher was to integrate within an organisation through the position of an internship, in order to gain a first hand perspective of the way in which organisations implemented design-led approaches to innovation. The primary appeal of the method was the extent to which it provided the opportunity to consider explicit and tacit knowledge simultaneously, within the environment in which they were generated. Data would have been collected through interviewing collaborators within the organisation, whilst a reflection-on-action approach (Schön, 1991) would have been adopted in order to understand the research activities at a more tacit level. Whilst the approach seemed like a suitable one, it soon became apparent that it would be particularly difficult to implement.

When attempting to recruit participants for the study, the organisations approached seemed reluctant to engage with the research to the extent that was necessary in order for the appropriate data to be collected. One particular organisation seemed keen to engage, with the decision to go forward with the study falling to the Chief Design Officer of the organisation who then decided that it would conflict with on-going consultancy work within the organisation and therefore wouldn't be appropriate at that time. This difficulty is echoed by Salvador *et al.* (1999) who finds that those who would most benefit from this type of work within a corporate setting are also those most likely to question its relevance, given that it challenges the traditional operating perspectives of business and production. On reflection, participant observation is clearly a suitable methodology for collecting the data, however getting to a position where an organisation is willing to engage with the research is extremely difficult. The approach could be utilised within future studies, however engagement with organisations would need to be sought during the early stages of the research, ideally with pre-existing contacts, due to the time and efforts needed to successfully arrange a collaboration.

4.4.2 Repertory Grid Interviews

Björklund (2008) expresses that the repertory grid method is capable of eliciting underlying tacit knowledge by offering a rich source of interpretative data that can be

explored collaboratively with respondents. A repertory grid is a table or matrix that contains data capable of eliciting personal constructs in relation to a given topic. The method was derived by Kelly (1955), who expressed that people are continually engaged in the process of devising new theories, testing hypotheses based on these theories and acting on their findings. The process has been described as personal construct theory, in which individuals construct rational worlds based on their experiences, shaping a pattern that can be defined as 'personal constructs' (*ibid.*). The repertory grid is a way of articulating these constructs and revealing the way in which people organise their social world. The system of personal constructs then becomes a repository of what a person has learned, a statement of their intent, and the values by which they live (Candy, 1990). Through the repertory grid method, respondents build up a construction of their own reality in given situations and derive more and more constructs until eventually a complex picture of one's reality is formed; thus demonstrating the way in which a person organises their social world, which is then open to interpretation (Gribbin *et al.*, 2016).

A repertory grid takes the form of a table or matrix that can contain either quantitative or qualitative data. Tables consist of elements, which define the area of study and rows of constructs, which are themes that link various elements together (Giles, 2002). Constructs in the grid are always bipolar, meaning that thy comprise two opposing values, which helps to ensure that they can be distinguished from other concepts. When conducting a repertory grid interview, the facilitator can ask questions in a way that targets emergent and implicit constructs (Fransella *et al.*, 2004). Emergent polls can be derived by asking a person to explain a way in which two elements of a triad are in some important way similar and thus different from the third element. In order to uncover implicit constructs, the facilitator can then ask how the third element is different from the two that were stated to be similar. Within this triadic approach to construct elicitation, it is also possible to elicit further constructs from the initial constructs that the subject provides through a procedure called laddering. Hinkle (1965) describes laddering as creating constructs of a higher order of abstraction than those elicited from the original triads and it is carried out by asking participants to generate further constructs based on the ones already identified (Crudge and Johnson, 2007). Through this process, the repertory grid is capable of eliciting implicit constructs that would not be possible to elicit through regular interview techniques as the information is not typically stored in verbal form. Therefore, asking participants to consider implicit constructs in this way begins to uncover some of the tacit knowledge that they possess (Gribbin *et al.*, 2016).

There are several advantages to the repertory grid method; in particular it allows a researcher to understand the world view of others without misinterpretation from an outside source. It is easy to talk to a person and believe that we have understood them,

however through a repertory grid interview their personal constructs are well understood, minimising the risks involved with our own thinking being transferred to the situation (Jankowicz, 2004). Spending time developing bipolar constructs ensures that there is minimal interruption from the facilitator leading to specific insights into situations, reducing the potential for bias as a research method. Conversely, authors have found that the time taken to implement the repertory grid can be one of the primary disadvantages to the application of the method, particularly when compared against alternative psychometric tests (Anderson, 1990; Tofan *et al.*, 2011).

Taking everything into account, the repertory grid method appeared to be a suitable candidate for a research methodology. The suggestion that the interviews were capable of eliciting tacit knowledge through the generation of constructs made the method particularly appealing, as it would have been able to provide firm insights into the underlying knowledge necessary in order to successfully implement DLI. As a result, a pilot study was conducted in order to test the suitability of the method for this particular piece of research. The pilot study consisted of a combination of repertory grid interviews and observation of a student cohort as they carried out a project for a multinational consumer goods organisation that focuses on the production of health, hygiene and home products. The project itself lasted for three months, in which the students were expected to generate a range of solutions that focused on a specific problem relating to the packaging of products. The student team consisted of six postgraduate students in total, four of which had a background in business or management and the remaining two specialised in design. The student project team was also supplemented by the advice of various lecturers from the University.

In this instance, the repertory grid interviews that were carried out upon completion of the student project provided a range of insights into the individual learning of the students throughout the course of the project, however the responses of the students were not as detailed as was anticipated prior to facilitating the interviews. In particular, students struggled with the concept of laddering constructs, which meant that the method failed to live up to its potential as a tool for eliciting implicit constructs that are capable of providing insight into the tacit knowledge that was utilised throughout the project. Subsequently, it was determined that the repertory grid technique would need to be subject to further refinement in order to be suitable for the remainder of the research project, particularly in order to be capable of offering insights beyond that provided by easier to implement methods such as semi-structured interviews. At the time of completing the pilot study, the turnaround before starting the next case study was relatively short, which meant that there was not enough time to further refine the method before collecting the remaining data for the study. Subsequently, alternative methods were utilised.

It is worth noting that the findings from the pilot study did generate insights that were relevant to the study, particularly regarding understanding the disciplinary dynamics within multidisciplinary teams. These findings are presented in the paper ‘understanding the dynamics of attitudes within a design and business focused collaboration’ (Gribbin *et al.*, 2017). Future research should seek to refine the repertory grid methodology and apply it within this context in order to build on the findings presented as part of this research, particularly in relation to understanding the tacit knowledge required in order to successfully implement design-led approaches to innovation.

4.4.3 Other potential methods

Other potential methods that were considered as part of the study include grounded theory and appreciative inquiry. Grounded theory was initially proposed by Glaser and Strauss (1967) as a systematic generating of theory from data that itself is systematically obtained from social research’ (Glaser, 1978). It is an inductive method of generating theory through the simultaneous collection and analysis of data with the goal of generating relevant and significant knowledge through social research. Its limitations surround researchers blurring methodological lines by selecting purposeful instead of theoretical sampling (Charmaz, 1990), which must be controlled by sampling based on emerging theory. Grounded theory appeared to be a viable option alongside the repertory grid interview strategy, whereby the goal was to derive fresh insights into the case studies through the exploration of emergent tacit knowledge, which is highlighted by its use alongside case study research within Gribbin *et al.*, (2016), however once repertory grid became a less viable option the use of grounded theory was also reconsidered.

Appreciative inquiry has been described as a methodology that takes the idea of social construction of reality to its positive extreme; with a particular emphasis placed on metaphor and narratives, relational ways of knowing on language and on its potential source of generative theory (Gergen, 1994). According to Cooperrider and Whitney (2001, p.614) 'appreciative inquiry is about the co-evolutionary search for the best in people, their organisations, and the relevant world around them’. It involves the systematic discovery of what gives life to a living system when it is most effective and capable in economic, ecological and human terms, whereby the goal is to determine factors that strengthen the systems capacity to apprehend, anticipate and heighten positive potential (*ibid*). Bushe (1995) describes appreciative inquiry as the most important advance in action research in the past decade, however appreciative inquiry is fundamentally a constructionist view of organisational behaviour as opposed to the constructivist philosophy adopted as part of this research study. As a result, it was not compatible with the chosen research strategy.

4.4.4 Summary of explored methods

Section 4.4 has outlined relevant research methods across the design and management research studies that were prominent within the literature review chapters, 2.0 and 3.0, in order to evaluate suitable methods for this study based on the wider research field. This analysis led to a discussion of participant observation and repertory grid based interviews as potential methods of data collection for this study. Both of these methods were explored during the early stages of the research process, however for various reasons, such as access to organisations and time restraints, they were deemed unsuitable with the context of the study despite their initial promise. The next section will outline the methods that were utilised as part of the final research design.

4.5 Approach to literature review

Literature reviews have been described as 'an essential feature of any academic project. An effective review creates a firm foundation for advancing knowledge. It facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where research is needed' (Webster and Watson, 2002, p. xii). Thus, a researcher cannot perform original or significant research without first understanding the literature in the field (Boote and Beile, 2005). Jancovicz (2005) also notes that a literature review also includes a search for an analytical framework, or frameworks, which can be used in order to test a hypothesis or systematically investigate a set of issues. Ultimately, the purpose of a literature review is to demonstrate an understanding of a subject including theories that have evolved over time, including the strengths and criticisms of them, in order to establish a solid foundation for future research (Baker, 2000).

The literature search process was on-going throughout the project in order to ensure that recent developments within the field were taken into account as the study progressed. Despite this, the majority of the literature search was conducted in two distinct phases at the beginning of the project. The first of which was a divergent process covering a range of subjects including the domains of design, design management, knowledge, business processes, organisation theory, organisational culture, and much more. This broad foundation was essential in understanding the wider field of influential research in order to understand its impact on the focal area of study. The second stage of the literature review process was convergent, focusing specifically on the way in which organisations implement design-led approaches to innovation; in particular through the lens of maturity frameworks as a tool to understand the process. The second stage was important in contextualising the findings from the study and identifying potential areas of new knowledge for the research.

4.6 Design of the study

This section will document the methodological choices that were made throughout the research process in order to collect the data set.

4.6.1 Case study research

The collection of primary data occurred under the general guidance of a case study approach. Yin (2014, p.2) describes a case study as a methodology capable of investigating 'a contemporary phenomenon in its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident'. Cresswell (2002) offers a similar insight, claiming that a case study is a problem to be studied, which will reveal an in-depth understanding of a case or bounded system, which involves understanding an event, activity, process or one or more individuals. In line with the research philosophy adopted by this research, Baxter and Jack (2008) note that the case study approach is often based on the constructivist paradigm in which the truth is relative and dependent on one's perspective. Eisenhardt (1989) suggests that case studies frequently combine a variety of methods, which may be qualitative or quantitative in nature. Within this study, semi-structured interviews play an important role in the data collection process, whilst aiming to adhere to the outlined units of analysis.

According to Yin (2014) a case study design should be considered in instances where either: the focus of the study is to answer a *how* or *why* question, the researcher is unable to manipulate the behaviour of those involved in the study, when the researcher intends to uncover contextual conditions because they are relevant to the phenomenon under study, or when the boundaries are unclear between phenomenon and context. The research question of 'how do multinational science and technology-led organisations adopt a design-led approach to innovation?' fits Yin's (ibid.) clarification of when a case study would be appropriate. Equally important in answering the research question is the context in which design is being implemented, as each individual case has a number of factors within the operating context of the organisation that must be considered in evaluating the success of implementing DLI into organisational strategy.

Within case study methodology, Yin (2014, pp.7-8) offers three distinct types of study: exploratory, descriptive and explanatory. Exploratory cases are those that have a purpose of exploring a phenomenon within its real-world context, whereas descriptive studies aim to describe the case in its real-world context and an explanatory study aims to explain how or why a condition came to be. In addition to the three types of case

study proposed by Yin (*ibid.*), Stake (1995) uses the term intrinsic to describe cases in which the researcher has a genuine interest in a case and uses the approach with the intent to better understand a case, as opposed to undertaking a case because it illustrates a particular problem. Baxter and Jack (2008) argue that this approach differs in approach to the others in that the purpose is not to understand a generic phenomenon but instead to understand a single example within a context of interest to the researcher. Stake (*Ibid*.) also outlines *instrumental* cases as those in which the aim of the study is to provide insight into an issue or help to refine a theory, where the case is often playing a supportive role to the research by facilitating our understanding of something else. The approach of an exploratory case study is best suited to this research; due to the initial aims of the research, where the goal is to explore DLI within the context of various organisations in order to determine whether any conclusions can be made in relation to best practices for implementing DLI within similar organisations.

Within exploratory case studies, there are various approaches that can be taken with regards to research design. Yin (2014) outlines four basic types of designs for case studies, outlined in Figure 3.

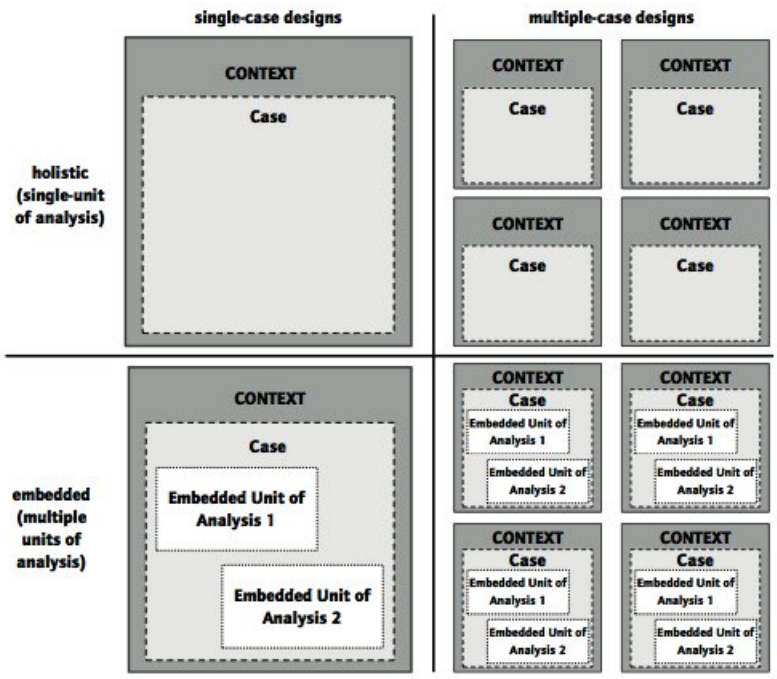

Figure 3: Types of case study (Yin, 2014, p.50).

The first decision facing a researcher at this stage is whether to adopt a single or multiple case design. According to Yin (2014), single case designs are appropriate in five particular circumstances where the rationale is having either a critical, unusual,

common, revelatory, or longitudinal case. Each particular circumstance has a clear rationale for adopting a single case design, however the design is vulnerable to criticism in that 'they require careful investigation of the potential case, to minimise the chances of misrepresentation and to maximise the access needed to collect the case study evidence' (*ibid.*, p.53). Alternatively, Yin (2012) notes that the multiple case design is usually more difficult to implement in comparison to a single case design requiring both greater resources and time, however the resulting data can provide greater confidence in the findings. This is echoed by Herriott and Firestone (1983) who note that multiple case study designs offer evidence that is more compelling, leading to a more robust study. Thus, the selection of a multiple case design aims to examine complementary facets of the main research question in which two or more cases deliberately try to replicate findings under similar conditions. The multiple case design is utilised within this research, with the intention of producing similar findings across three specific cases, which can then be generalised to future cases under similar conditions.

The researcher must then make a choice between a holistic or embedded approach towards the unit(s) of analysis utilised in the study. As highlighted in Figure 3, holistic approaches focus on a single unit of analysis within each case whereas an embedded approach utilises multiple units of analysis. Gerring (2013) defines a unit of analysis as a spatially delimited phenomenon observed at a single point in time or over a period of time. Tellis (1997) notes the importance of units of analysis within case study research, indicating that the specification of the unit of analysis provides internal validity to the research as data collection and analysis is utilised in testing proposed theories. The study adopts multiple units of analysis influenced by the chosen analysis framework, which is expanded upon in Section 5.2. In order to understand how DLI was integrated across organisations the data collection strategy aimed to capture the views of various stakeholders across different stages of the implementation process where possible in order to understand how the influence of design in decision making changes over time. Subsequently, the study is adopting a multiple case embedded case study design.

4.6.2 Selection criteria

When adopting a multiple case study approach the selection criteria centres on the concept of external validity, ensuring that the generalisability of the findings can be established through the replication logic of the multiple case design(Cresswell, 1994; Shakir, 2002). Within the multiple case design there are two types of replication that are sought after (Yin, 2014). Literal replication occurs in instances where typically three to four cases are selected to predict similar results when rival theories are grossly different (*ibid.*). Conversely, theoretical replication is utilised in instances where cases are selected in order to predict contrasting results across two sets of three to four

cases, when rival theories have subtle differences (*ibid.*). This study seeks to establish literal replication across three cases in order to extend emergent theory (Eisenhardt, 1989). The selection criteria were developed as follows:

Each of the selected cases had to be engaged in embedding DLI within the organisation. It was identified that potential organisations could have been at one of three different stages of implementation and still be considered relevant to the findings of the study. In the first instance, the organisation could have been about to embark on utilising DLI alongside their innovation practices. In this case, the researcher would follow their progress over a period of time in order to gain insights into the initial barriers and enablers to integrating design within organisations. Another possibility was engaging with organisations that were some way through implementing design practices. Design would not yet be in an influential position strategically, however it would have progressed towards that aim from having identified DLI as a potential value source to the organisation. Finally, the organisation may have recently sought to embed design into their practices and had somewhat succeeded in their attempts. In this instance, the focus would be on reflection in order to understand the processes that the organisation had gone through in order to achieve their goals. In each instance, the cases would provide data relevant to the research question, with the primary differentiator being the perspective from which the data was collected, depending on the stage of implementation each organisation was at.

In order to meet the criteria of the research question (outlined in Section 4.1) and generate new knowledge, it was determined that multinational organisations would be most appropriate for the study. The literature review outlined an abundance of studies that focused on design integration within SMEs in order to add business value, however there was a lack of significant studies that had a focus on design integration within larger firms. In reaching out to organisations to take part in the study, it soon became apparent that the firms most willing to engage with the study had strong foundations in either science or technology. Thus, given that the relevance of the research was applicable across all sectors of corporate manufacturing industry, it was logical to refine the selection criteria further to specify that selected organisations would have a background in one of these two areas in order to improve the generalisability of the findings towards a specific industry sector.

Finally, factors surrounding the logistics of utilising particular organisations as cases were considered. Factors such as the willingness of an organisation to engage with the research were considered at this stage, as well as factors surrounding the scheduling availability of each organisation in relation to the wider project. Each of the final cases had previously engaged with Northumbria University in some way, which meant that they had shown a willingness to engage with research previously. Building on this

existing relationship led to success in recruiting cases, particularly in comparison to instances where organisations had been approached independently. Furthermore, the geography surrounding each of the cases also played an important role in the research. Although all three cases are multinational organisations, they each have facilities located in the North of England, which made it easier to coordinate the research within cost and timeframe restriction.

Each of the aforementioned selection criteria led to the final selection of three cases: Organisation A, Organisation B and Organisation C. A brief summary of each organisation is provided below with a more detailed explanation of their activities in relation to implementing DLI provided in Chapter 6.0.

Organisation A is a Fortune 500 US manufacturing company which specialises in engineering, focusing on the creation of a variety of products that range from motion control technologies to industrial filtration. They had recently succeeded in integrating design into their innovation processes at a regional level across Europe and have ambitions to grow the influence into international divisions. The aim of this case was to understand the factors that underpinned the success of the division in implementing a design-led approach to innovation.

Organisation B is a multinational fast moving consumer goods organisation who have a global portfolio of over four hundred brands. They are some way towards design having an influence at the strategic level, however they have faced several internal barriers in their attempts. Here the aim was to understand how design-led approaches to innovation has established the discipline within the organisation currently, as well as understanding the barriers that are making future growth difficult.

Organisation C is a global manufacturer and supplier of subsea equipment based in the North of England. Their innovation processes have traditionally relied upon incremental innovation to existing products, however recent market trends have meant that they are looking to design in order to differentiate themselves from their competitors in a difficult market space. The aim was to understand the initial stages of design integration into the organisation and track the project over a period of time.

Data collection across each of the three cases involved interaction with a variety of stakeholders. The specific way in which the data was collected will be discussed next.

4.6.3 Semi-structured interviews

As mentioned in Section 4.6.1, either qualitative or quantitative methods can be utilised as part of case study research. This study has adopted a qualitative approach, guided

by an overarching philosophy of constructivism, in the form of semi-structured interviews. The process of interviewing has been described as ‘a conversation with purpose’ (Kahn and Cannell, 1957, p.157), with semi structured interviews containing a predetermined order of questions whilst enduring flexibility in the way issues are addressed by participants (Dunn, 2005). Semi-structured interviews have been described as one of the most commonly used qualitative methods (Kitchin and Tate, 2000) and are also prominent within design research, as highlighted in Table 3.

Despite the prevalence of semi-structured interviews within the literature, there are associated limitations and weaknesses to the method that needed to be considered. Marshall and Rossman (2006) identify several limitations to the approach, with the most relevant to this particular study being: the necessity for cooperation from interviewees, the time consuming nature of data analysis, and the quality of the data in relation to the theoretical framework of a study. Cooperation from interviewees is about ensuring that responses to questions give an accurate picture of events, particularly in circumstances where there may be an element of discomfort in sharing the information necessary for the research (*ibid.*). Additionally, Douglas (1976) notes that there may be instances in which participants have ulterior motives for being interviewed and feel like they have good reason not to be truthful in their responses. Approaching organisations that had previously collaborated with the University in some capacity was useful in mitigating the limitations surrounding the cooperation of interviewees, as there was already an inherent level of trust that stemmed from previous collaborations. Furthermore, interviewing multiple people within each case helped to triangulate the data and ensure that the responses of interviewees were consistent within the context of the study and therefore represented an accurate and truthful account of the situation.

Within this study, the precise nature of semi-structured interviews differed in each case based on the stage an organisation was at in terms of integrating DLI. Within Organisations A and B, the interviews took place after each organisation had integrated design to a certain extent. The interviews in these cases were specifically aimed at helping participants to reflect on the process that they had been through in order to integrate design into their innovation practices. Due to the timing of the study, it was possible to conduct interviews during the initial stages of the integration of design practices within Organisation C, as well as after a period of approximately a year. Within this specific case, the initial interviews focused on the position of design at the beginning of the project as well as identifying the intentions of the organisation going forward. In the follow up interviews it was possible to ask questions relating to the progress that design has made over time and ask participants to reflect on their previous expectations for the work.

A summary of each case is provided in Table 4, including details of the people that participated in the research. In total, thirteen interviews were carried out with eleven people between October 2016 and February 2017. The duration of the interviews typically lasted between fifty minutes and one and a half hours. Each of the interviews was then audio transcribed word for word in order to aid the analysis process, examples two different transcripts can be found in Appendix A.

Organisation	Interview schedule	Data sources
A	Post integration	5 interviews: Industrial designer, Division marketing manager, Division engineering manager, engineer, Design lecturer
B	During integration	2 interviews: Designer, Design practice capability manager
C	Before & during integration	6 interviews: Design consultant (twice), Principal engineer (twice), Programme manager, Head of regional innovation centre

Table 4: Interview data sources.

The construction of interview questions is also a critically important stage in the semi-structured interview procedure. Several types of questions may be utilised across an interview including experience questions, opinion questions and feeling questions (Hove and Anda, 2005), with the primary goal of avoiding questions in which participants can only answer yes or no. The interview questions for each organisation differed depending on the stage that they were at in terms of integrating DLI, however the questions remained consistent in asking about specific themes identified in the analysis framework prior to conducting the interviews. Further information on the analysis framework can be found in Section 5.2, whilst the consistently applied questions can be seen in Table 5.

1	Can you briefly describe the organisation?
2	What is your official job title and how long have you held the role?
3	What are your key responsibilities within the organisation?
4	Can you describe the role that design currently plays within the organisation’s innovation processes?
5	How has this changed since the beginning of the intervention?
6	To what extent is the organisation supportive of the design process?
7	What is the overarching view of risk within the design process?
8	Where does design fit in relation to other key functions within the organisation?

9	What design capabilities does the organisation currently have and how has this changed since the introduction of design?
10	What role, if any, does design play in setting organisational objectives?
11	How defined are design processes within the organisation? Has a set way of working emerged?
12	To what extent do other disciplines understand the output of the design function?
13	Can you describe the background of the design project?
14	What was the anticipated value of introducing design and how do the outcomes of the project compare with this anticipated value?
15	Can you describe the main barriers faced throughout the introduction of design?
16	Are any of these barriers still in existence?
17	What were the key knowledge gaps in relation to integrating design-led innovation?
18	Are there any knowledge gaps still present in the organisation that you feel capable of describing?
19	Since the completion of the project, can you describe the impact that it has had on the innovation processes of the organisation?

Table 5: Foundation of questions for semi-structured interviews.

4.6.4 Identifying research participants and data sources

In order to protect the anonymity of the project stakeholders and organisations involved in the research, everyone that was interviewed as part of the data collection has been anonymised in order to preserve the security of their identity. To facilitate this process, pseudonyms have been adopted in order to enable fluent reading of the narrative. To derive appropriate pseudonyms, the names of the project stakeholders have been replaced with randomly selected names that use the first letter of their job title, as highlighted in Table 6.

Case	Pseudonym	Job title
A	Sarah	Senior Lecturer (Design)
A	Isaac	Industrial Designer
A	Emma	Engineering Manager
A	Mark	Marketing Manager
A	Paul	Principal Engineer
B	Penny	Packaging Designer
B	Chris	Capabilities Manager (Design Practice)
C	Harry	Head of Regional Innovation Centre

C	Peter	Programme Manager
C	Philip	Principal Engineer
C	Claire	Consultant (Design Strategy)

Table 6: Pseudonyms of project stakeholders alongside their job titles.

In discussing the outcomes from these interviews, all future statements from specific individuals can be traced back to the original location within the interview transcripts. Appendix A provides two sample transcripts, Isaac from Organisation A and Penny from Organisation B. A coding system is utilised to allow the reader to accurately trace statements back to the interview in which they occurred. The coding system works as follows: Figure 4 shows a section of the interview with Isaac, which occurs on page 9 of the transcription. A quotation or statement originating from this section of the interview would be denoted as (Isaac, p.9). In instances where participants have completed more than one interview, quotes will be coded with i1 or i2 in order to highlight whether the quote originated before the integration of design into the organisation or upon completion of the project. This is the case in Organisation C, where both Claire and Philip took part in an interview before and after the integration of design. In the case write up, this will look like (Claire i1, p.1).

JG: Who do you need to make a case for with things like that?

I: The engineering manager. So R&D have their own manager, product development which is another aspect of engineering have a manager and then industrial design is another aspect. Then they'll all report to the top engineering manager and that's how the structure works.

JG: Do you work with any other functions outside of the people that we've mentioned so far.

I: No, marketing, R&D and engineering are the main ones.

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Figure 4: Sample taken from Transcript 1 in Appendix A.

4.6.5 Ethical issues

According to Berg (2009, p.60) 'social scientists, perhaps to a greater extent than the average citizen, have an ethical obligation to their colleagues, their study population, and the larger society', given the extent to which social scientists investigate the social lives of other human beings. Several steps were taken in the collection and analysis of the data to ensure that appropriate ethical consideration was given to the research

process and that the research was conducted in line with the ethics guidelines established by Northumbria University.

In carrying out the study, the research utilised an informed consent approach. Berg (2009, p.87) defines informed consent as 'the knowing consent of individuals to participate as an exercise of their choice, free from any element of fraud, deceit, duress, or similar unfair inducement or manipulation'. Berg (*ibid.*, p.88) also notes that it is common for researchers to obtain consent in writing through the production of informed consent forms which contain 'a written statement of potential risks and benefits and some phrase to the effect that these risks and benefits have been explained. As a rule, these slips are dated and signed by both the potential subject and the researchers or their designated representative. It is usual for the researcher to briefly explain the nature of the research in this informed consent document, as well as offer an assurance of confidentiality and protection of the participant's anonymity'. This approach was followed closely within the data collection, with two separate informed consent forms being created. The first of which was utilised in the initial establishment of each case and explained the study to a representative from a senior management role that had the authority to authorise the research within the organisation. An example of this form is provided in Appendix B. The second consent form was presented to individuals at the beginning of each interview and contained an explanation of the study alongside a guarantee of anonymity in the publishing of findings. It was also explained to individuals that they had the right to withdraw from the study up to the point that the data analysis process had been completed. An example of this form is also provided in Appendix B.

4.7 Limitations to research approach

As identified in Section 4.4, both participant observation and repertory grid appeared to be potentially suitable methods to follow in the collection of the data. The primary benefit to both of these methods is that they appeared to be capable of presenting an opportunity to capture tacit knowledge within particular cases, either through an action research approach supplemented with reflection on behalf of the researcher or by facilitating reflection amongst participants. These approaches were deemed unsuited to the final study due to a difficulty in securing appropriate cases for participant observation and the need for further refinement in the repertory grid method. Subsequently, the research adopted semi-structured interviews in order to explore the research method, which was capable of generating appropriate data, however this data focused on explicit knowledge that participants were able to communicate as opposed to tacit knowledge through reflective practice. This leaves space for future research to adopt one of the two aforementioned methods as a way of collecting supplementary

data to this study and perhaps understanding some of the tacit knowledge required in the successful implementation of DLI.

Another limitation to note is that the involvement of a University across all three cases has implications to the way in which the research was carried out. Primarily, this was because the University involvement meant that the final cases may not be indicative of the way in which DLI is integrated during circumstances where a University is not involved in the process. In these situations, it is possible that the integration is led by external design consultants or an existing internal design resource, which is not necessarily reflected across the three cases in this study. In particular, the availability of staff in each case had the potential to impact timescales, as well as pressures surrounding University term cycles. Had the organisations solely enlisted the help of external design consultants rather than University, some of these restrictions would not necessarily have existed.

Additionally, it was difficult to carry out further methods in order to validate the data findings. Across each of the cases, job rotation meant that people who were interviewed as part of the study were no longer in the same job roles once the data had been successfully analysed. Furthermore, many of the people who were interviewed as part of the initial study had moved on to roles within other companies by the time the analysis process had been completed. This made it difficult to bring multiple participants together to participate in further activities such as workshops or interviews as a tool for data validation. This is perhaps a reflection on the nature and difficulty in carrying out this type of longitudinal research within larger organisations, whereby organisational change is a common feature of the day to day operating environment and as a result, organisations are in a constant state of flux. This is typified by Organisation B, in which job rotation is an essential part of roles within the company (as discussed in Section 6.3.4c).

4.8 Summary

This chapter has presented a detailed discussion of the philosophical and methodological choices that have underpinned the research process, a summary of which can be seen in Figure 5 which represents the methodological choices on the research onion diagram adapted from Saunders *et al*. (2009).

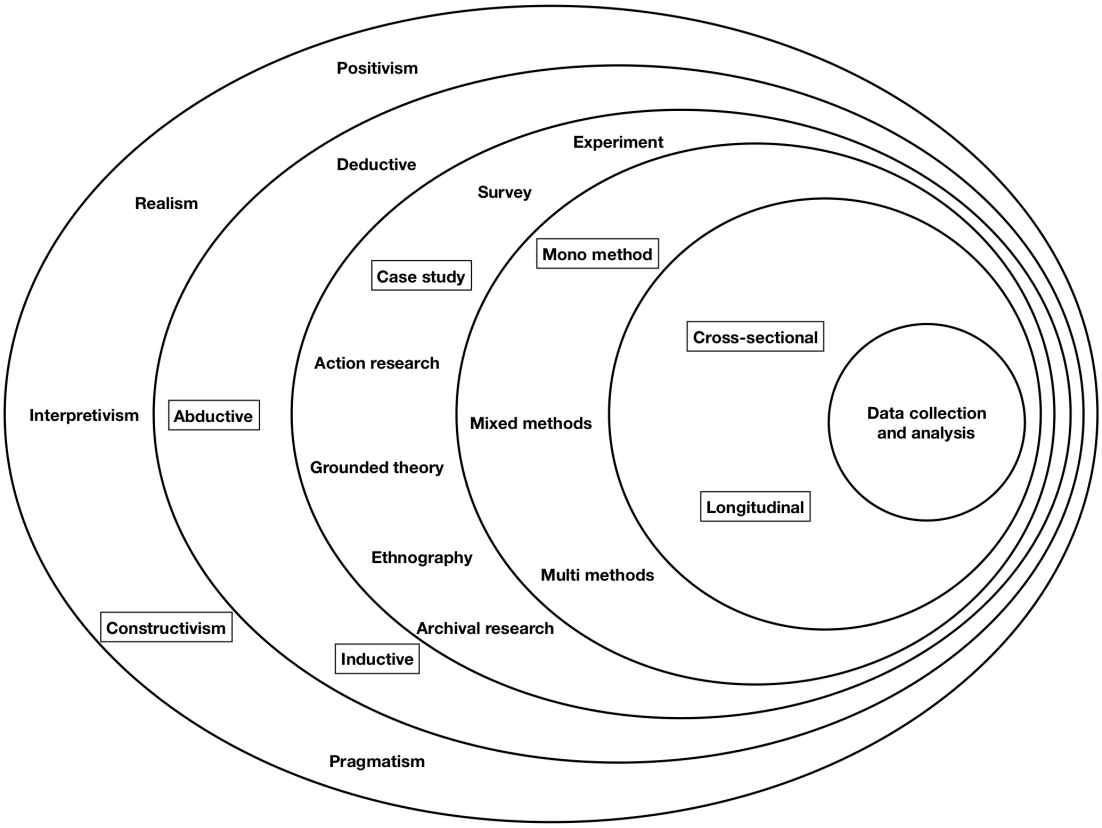


Figure 5: Methodology summary

The chapter presented a discussion of the relativist ontology and constructivist epistemology, which have supported critical decisions in selecting an appropriate research methodology for the study. Constructivism was particularly relevant to the study in that it emphasises that people create models of the natural world, thus knowledge is always a human and social construction. An approach of research into design was also specified (Frayling, 1993) as a useful frame for guiding the research in relation to wider design and management research.

Furthermore, a discussion of relevant methodologies within design and management research was presented. This led to an overview of participant observation and repertory grid interviews as two of the most relevant methods that could have been adapted for the study. On further reflection, it was explained why these methods were not utilised in the final study, however have potential to be deployed as part of further research into the field, providing subsequent researchers have the available resources to overcome the shortcomings that were present at specific points during this study. Subsequently, the use of semi-structured interviews within the guidance of case study research was adopted as a suitable method of data collection across three organisational case studies. Having explained the way in which the data was collected, Chapter 5.0 will seek to outline the way in which the data was analysed.

5.0 Creation of a conceptual framework and the analysis of data

Having presented the way in which the data was collected throughout the study, this chapter will focus on outlining the process utilised in analysing and synthesising the data acquired across each case study. The chapter will first explain the conceptual framework utilised in framing the analysis, before explaining how the data was coded within the framework in order to produce themes that have led to the generation of theory.

5.1 Conceptual framework

Critical to the analysis process is the use of a conceptual framework that can be utilised in order to make sense of the data. Miles *et al*. (2014) highlight the importance of a conceptual framework in order to explain the main factors that are being studied and the presumed interrelationships amongst them. They play a significant role in helping a researcher to decide the importance of selected variables and also provide a framework for determining the significance of relationships in the data. Theory building through the analysis process relies on ‘a few general constructs that subsume a mountain of particulars’ (ibid., p.21), with constructs such as culture, social intelligence and identity examples of labels that can be placed on intellectual ‘bins' containing many discrete actions, states, variables, categories processes and events. Understanding these ‘bins’ within the context of the study by naming them and being clear about their interrelationships is critical in devising a suitable conceptual framework (ibid.).

Within the context of this study, maturity frameworks appear to be a suitable candidate for a conceptual framework that can be used in order to synthesise the data and relate it back to the initial research question of seeking to understand the way in which organisations implement design led innovation. Chapter 3.0 outlined the general uses of maturity frameworks within design research: as a tool for demonstrating design’s ability to add value to organisations, as a tool to describe maturity in the context of a product life cycle and as a tool for documenting design’s influence within organisation innovation processes. This section will build on the discussion of maturity frameworks presented within the literature review in order to establish the suitability of relevant frameworks that have potential to act as a conceptual framework for this study.

Pettigrew *et al*. (2016) argue that few maturity frameworks provide insight into their derivation or underpinning theoretical foundations, either academic or business based and as a result provide a minimal basis for rigorous research. Despite this criticism, several frameworks have been utilised extensively in academic research to understand

the forms that design can take across organisations. In particular, the Danish design ladder, the Innovation capability maturity model, the Design Management Institute maturity matrix and the Philips framework all offer a substantive basis for research in the area. In order to distinguish between the frameworks, Table 7 documents the benefits and drawbacks to each of the frameworks in relation to their suitability for this particular piece of research. The first two columns of the table indicate the origin of the framework and the context through which it was initially devised. The levels and factors columns aim to describe the stages that design is said to follow in each model. Subcategories occur in two of the frameworks when outlining the factors, this is indicated in the table through the use of brackets to demonstrate the subcategories within the primary set of factors. Benefits and drawbacks to each of the frameworks are then considered, specifically in relation to their use as an analysis framework for this piece of work, as opposed to a more general critique of each framework. In order to compliment the reading of Table 7, a copy of each of the four frameworks is provided in Appendix C.

Framework origin	**Purpose/ Context**	**Levels**	**Factors**	**Benefits**	**Drawbacks**
Design Management Institute (Westcott *et al.*, 2013).	Highlight the value of design to organisations	5	3	• Grounded in professional practice. • Has been applied to multinational organisations. • Success being utilised as a benchmark for design integration.	• Doesn't explain individual factor criteria, leaving the framework open to interpretation. • Specific to highlighting the value of design rather than the strategic influence.
Danish design ladder (Danish Design Centre, 2015).	Highlight the economic effects of design	4	N/a	• Straightforward in visualising the path that design typically follows within organisations. • Commonly utilised in similar academic studies.	• Generic and non industry specific. • Only measures integration outcomes at an operational level. • Inadequate description of non-design. • Lack of detail surrounding the factors that effect the level rating.
Philips framework (Gardien and Gilsing, 2013).	Help organisations turn their design capability into a strategic tool.	3	3 (9)	• Derived within a multinational technology led organisation. • Documents the successful integration of design at the strategic level of an organisation.	• Assumes an existing design capability within the organisation. • Specific to a single organisation. • Inadequate description of non-design.

Innovation capability maturity model (Essman and du Perez, 2009).	Identify the fundamental principles of innovation that contribute to organisational innovation capability.	N/a	3 (11)	• Considers factors that are both internal and external to the organisation. • Highlights the relative strengths and opportunities to an organisation using quantitative measures based on individual perceptions. • Not specific to any single organisational context, therefore can be applied in a range of settings. • Strong focus on knowledge management.	• Not specific to the design discipline and would need significant adaption in order to document the factors surrounding the integration of design within organisations. • Limited discussion surrounding integrating innovation into the organisation's culture.

Table 7: Benefits and drawbacks of existing maturity frameworks in relation to the research question.

Whilst there are clear benefits and drawbacks to each of the frameworks in relation to their suitability for this particular study, it was necessary at this stage to make a decision as to what framework offered the most appropriate lens through which the data could be viewed. In order to facilitate this process, a set of selection criteria were identified. Most importantly, an ideal framework would have a solid basis in academic theory, yet would also be grounded in professional practice. Furthermore, the framework would also need to be fluid in its understanding of design's transition within organisations; providing a detailed explanation of the factors that effect the level of influence that design has at various times. A detailed explanation of various factors would provide clear units of analysis for the study, which is necessary when conducting case study research.

Taking the selection criteria into account, the framework offered by Gardien and Gilsing (2013) within the context of Philips Design was chosen as the best available option for the analysis of data. The framework was derived in order to chart the transformation of design within Philips from an ad-hoc service provider to a function capable of influencing the strategic thinking of the organisation. To achieve this, the framework itself provides detailed descriptions of prominent features at each level of maturity, meaning that the framework can be utilised for benchmark design performance within other organisations. These descriptions are also suitable to provide the units of analysis for the dataset.

Furthermore, the framework meets the requirement of being developed within professional practice and thus is reflective of the outcomes that subsequent organisations might undertake should they follow a similar process in the future. Similarly, the framework also appears to have a degree of academic rigour. The authors identify design as an approach, design as a capability and design as an outcome as common features of academic research, however state that no studies had combined each of these facets in order to provide a holistic view of design integration. Wolff and Amaral (2008) independently proposes a similar finding, highlighting that competencies, processes and strategy are critical components of 'design understanding' within organisations and suggests that they should be components of a new scale capable of measuring the role of design within company performance. These two studies share commonalities in the way that they underpin the importance of 'who designs', 'how they design', and 'what they design' (Gardien and Gilsing, 2013, p.60), which is viewed through the design community within an organisation, the process of design thinking and co-creation that is utilised to generate new ideas collaboratively with other disciplines and the specific contribution that design makes to the business.

Despite the benefits of the framework in relation to meeting the selection criteria, the drawbacks also need to be considered. One of the primary drawbacks of the framework is that it assumes an organisation has an existing design capability and therefore does not track the initial implementation stage. The phrase 'non-design' is extensively covered in other frameworks, in particular in the Danish Design Ladder, and is essential to any research considering how organisations develop from having no formal design capability into organisations that are capable of using design to influence company strategy.

5.2 Adapting the Philips framework

One of the main drawbacks of the Philips framework in relation to the current work stems from the assumption that organisations already have a level of design capability present. As Chapter 3.0 highlighted, this is not always the case and there are often organisations that have little to no formal design capability. As a result, it was necessary to adapt the framework in order to capture the earlier stage of design integration that is not covered in the existing Philips framework. In order to achieve this, the work of Aftab (2013) was built on, in particular a timeline of the projects that occurred within Philips prior to the time period discussed in the adaptation of the maturity framework (Appendix D). The timeline indicates that earlier projects within Philips were about understanding the essence of what design means to the organisation in its current format. This led to the creation of a 'maturity level 0', which describes the period prior to design's integration as a formal function. Within Philips, design played an auxiliary role providing support to the other functions of the

organisation, however in a general framework this stage can also be utilised to describe the initial efforts of organisations to integrate design in a small way. This could be through the implementation of a design project with external stakeholders or by taking steps to employ designers within the organisation for the first time.

Having used the timeline (Appendix D) to establish a maturity level 0 within the framework, it was also possible to use the timeline, alongside the existing framework responses, in order to derive criteria for design as an approach, design as an outcome and design as a capability at this stage. The descriptions at maturity level 0 are focused around understanding what design could be in the context of the organisation as well as understanding that design is likely to be an isolated function at this stage of its integration. As such, there will be increased tension between design and other functions caused by a lack of understanding surrounding the design process, which is mirrored in other disciplines having no awareness of the potential of design in creating business value. This is echoed by the statement that design is also likely to be seen as a subset of a separate discipline within the organisation, typically marketing, which has a profound effect on establishing a strategy for design within the company. Figure 6 shows the adapted version of the framework that was used in the analysis process, with the included maturity level 0 being the primary change from the initial framework.

	Maturity level 0: Understanding what design means to the organisation	Maturity level 1: Within function but in context	Maturity level 2: Integrated and aligned with other functions	Maturity level 3: Measurable impact on business result and performance
Design strategy	- Design strategy seen as a subset of marketing strategy. - Work out what a design strategy means for the organisation.	- Design strategy leads to design objectives, KPI's and improvement programs.	- Integral part of all short, medium and long term business objectives.	- Measurable influence on the long term vision and direction of the company.
Design programming	- Scoping the potential need/purpose of a design program.	- Design programs are derived from business programs. - Prioritisation based on business needs.	- Participation in business programming and road mapping leads to design programs. - Prioritisation based on potential return.	- Integral part of management decision process. - Measurable influence on the direction of business programmes
Design delivery	- Projects carried out in isolation.	- Design process defined. - Resourcing within the function. - Receiving design brief.	- Design process and resource planning integral part of business process and footprint business. - Ownership on briefing process	- Design delivery strategy based on measurable effectiveness and efficiency and supports future value creation.
Design to innovate	- Thinking about how design could be positioned alongside other organisation functions.	- Programmed contribution to innovation projects. - Aligned with innovation themes.	- Front end activities ensuring uptake. - Design as co-author of innovation roadmap and research themes, including front-end.	- Design and design thinking contributes to redefinition of existing markets and categories. - Pushing new paradigms e.g. ecosystems.
Design to differentiate	- Design understanding where it can improve the propositions offered by existing technologies.	- Contributing to the creation of management and orchestration of total brand touch points per category.	- Design facilitates the coherency of brand expression across all touch points.	- Design thinking contributes to defining the direction of the brand strategy and identity.
Design to optimise	- Understanding where design tools could fit within current processes.	- Contributing to simplifying and value engineering design solutions.	- Design facilitates the creation of optimising platforms, roadmaps and standardisation on a program level.	- Design thinking contributes to optimised processes, portfolios and value chain (end to end).
Design skills	- Identifying the design skills that are present within the organisation. - Understanding knowledge gaps that are present.	- Access to all design expertise's (comm. prod. serv...) - Talents identified - Job rotation within the organisational entity (sector)	- Internal and external expertise leveraged in projects. Succession planning leads to new design leaders. - Job rotation within the function (company).	- World class design expertise. - Talent management extending to partners and universities. - Design thought leadership recognised as benchmark.
Competence development	- Mapping out existing design competencies present within the organisation.	- Areas for best practice defined. - Relevant design information available and accessible.	- Internal and external collaboration increases competence and knowledge level. - Knowledge dissemination embedded in ways of working.	- Design competence recognised as benchmark - Design knowledge integrated in business knowledge management contributing to learning organisation.
Culture for design	- No awareness of the full potential of design in creating business value.	- Little awareness in the organisation on the full potential of design to create business value - Design seen as costs	- High awareness that investments in design are essential for NPS, brand equity and innovation.	- Design provides inspiration at a strategic level, while supporting direction setting and the creation of meaningful solutions on an operational level.

Figure 6: Adapted version of the Philips framework.

5.3 Data cleaning

The data collected from each case study totalled approximately eleven hours of combined audio. The first stage of the analysis therefore, was to convert the audio files into a common format that could be used to facilitate the analysis process. Furthermore, Miles *et al.* (2014) recommend that data should have the same layout, font size as well as highlighting the difference between interviewer questions and interviewee responses. Similarly, it is suggested that a consistent transcription style is used across all of the recordings in terms of the level of detail provided; thus a firm decision should be made beforehand about including aspects such as pauses, mispronunciations or incomplete sentences (ibid.). Rahm and Do (2000) describe this process data cleaning, with the purpose of removing any errors or inconsistencies from individual data sources. As part of the data cleaning process, all of the interview audio files were transcribed by an independent transcription service and then checked for accuracy and anonymity by the researcher.

5.4 The data coding process

This data cleaning process resulted in several transcript documents for each of the cases, a sample of which are provided in Appendix A. At this stage, it was necessary to make a decision as to whether the coding process should be carried out by hand or facilitated by the use of coding software. Saldaña (2016, p.4) describes coding as a method of qualitative inquiry that is most often a word or short phrase that symbolically assigns a summative, salient, essence-capturing or evocative attribute for a portion of language-based or visual data. In carrying out this process, it is possible to use coding software such as NVivo in order to facilitate the process, with the alternative being to code the entire dataset manually by hand. Each approach is beneficial in particular circumstances, with the manual approach allowing the researcher to have more control and ownership of the work, whilst the electronic approach efficiently stores, organises, manages and reconfigures data to allow human analytic reflection (ibid.). The nuances of each approach are considered in greater detail within the following two sections.

5.4.1 Overview of a qualitative software coding approach

John and Johnson (2000) provide a detailed discussion surrounding the strengths and weaknesses of qualitative coding software, with primary benefits surrounding the validity and rigour of the approach. It can allow researchers to examine all data related to a topic without the presence of human tendencies to privilege data that fits with preexisting world-views. Furthermore, segments of data are unlikely to be lost or overlooked as the software will highlight all instances of a code within a dataset (*ibid.*). Practical benefits to the application of coding software have also been emphasised, in

particular the convenience and efficiency of the approach that can reduce the manual and clerical tasks associated with qualitative research (Russell and Gregory, 1993).

There are, however, drawbacks to the use of qualitative coding software. In particular, there is concern surrounding the ability of software packages to integrate, analyse and meaningfully understand very large amounts of data (John and Johnson, 2000). Attempting to manage large volumes of data in this way also has the potential to lead to insubstantial analysis, because the focus of analysis would be on quantity rather than quality of meaning (Seidel, 1991). McLafferty and Farley (2006) also point out that the speed and efficiency of qualitative coding software can be offset by the time in which it takes a researcher to learn how to use and become familiar with a new software package.

5.4.2 Overview of a manual coding approach

The manual approach to coding is particularly useful in allowing a researcher to have greater control and ownership of the analysis process (Saldaña, 2016), which can be particularly useful within smaller scale studies (Bazeley, 2007). Saldana (2016) recommends handling the data in order to gain a literal perspective of the findings that is not always possible on a computer's monitor screen. Graue and Walsh (1998) note that handling the data in this way can lead to additional data contained in memory and turned into record.

The manual coding approach has clear benefits in terms of familiarising a researcher with a dataset, however, depending on the size of a dataset, the manual approach has also been described as a tedious and frustrating process (Basit, 2003), which can be slow and tentative (Dey, 1993). Additionally, the management, storage and reconfiguration of a dataset becomes much harder if the manual approach is favoured over electronic alternatives.

5.4.3 Outlining the selected coding process

For this study, it was decided to code the dataset by hand, a decision that was primarily determined by the extra control that a researcher is afforded throughout the process. Furthermore, interviewing people with different exposure to design practices led to differences in terms that were being used to describe similar phenomena; with this being the case a process of manual coding allows more flexibility to the researcher when faced with this issue.

Having established the use of a manual coding approach, Basit (2003) notes that there are two strategies that can be used to code data; the first of which occurring when a

researcher takes a grounded approach and does not pre-code any data until it has been collected and viewed within its context. The second approach is to create a provisional list of codes prior to fieldwork. The list could be derived from a theoretical framework, list of research questions, hypothesis or alternatively some key variables that the researcher brings to the study. The second approach is advocated by Miles and Huberman (1994), however a combination of these approaches were utilised at this stage of the study.

5.4.3a Coding phase one

The theoretical framework outlined within the adapted Philips framework offered two appropriate stages of coding the data. In the first instance, the data was coded based on whether a statement could be attributed to design as an approach, design as an outcome or design as a capability. More specifically, codes of: design strategy, design programming, design delivery, design to innovate, design to differentiate, design to optimise, design skills, competence development and culture for design were used to categorise the data. Figure 7 outlines an example of this process taken from one of the transcripts from Organisation B.

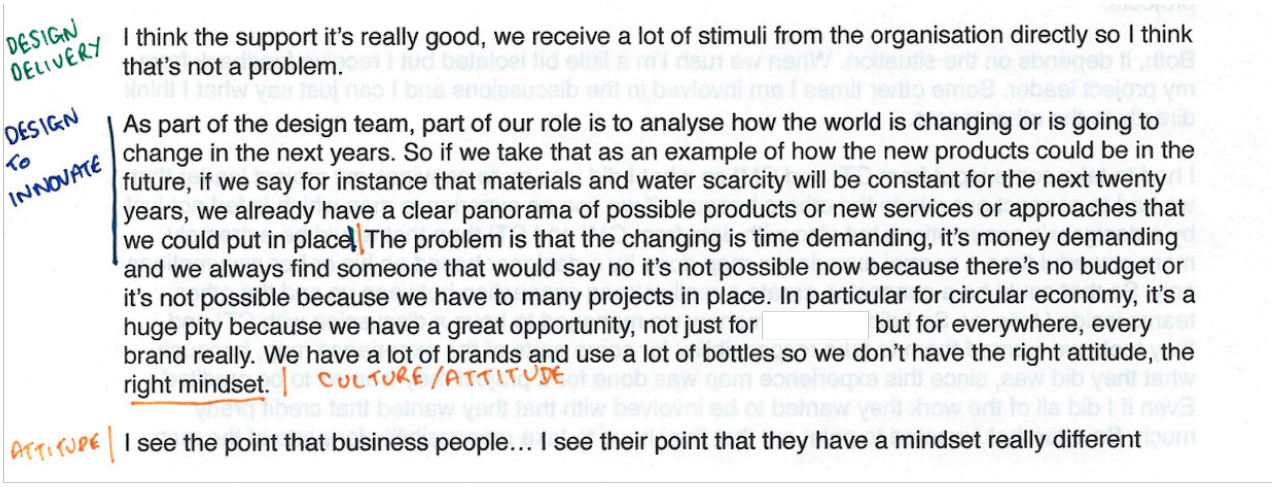


Figure 7: Example of initial coding by type of design.

Once this initial stage of coding was complete, the data was coded for a second time in order to determine whether a statement was indicative of a particular level of maturity. To do this, statements were given specific codes depending on whether they associated with a particular description of maturity. For example, a statement that could be associated with maturity level one within the design delivery category, shown in Figure 6, would be coded with a '1' followed by a letter 'a, b, or c' depending on which of the three statements is could be associated with. In instances where it was felt that a statement aligned with a particular level of maturity but not a specific statement from the matrix, a '?' was placed next to the number to highlight the statement as a potential

area for further development of the matrix. The data was then entered into tables and organised to reflect the type of design that a statement corresponded with as well as the level of maturity. Appendix E shows several examples of the tables utilised to code the data, including statements across each of the three primary types of design and at a range of maturity levels. The final column within the coding tables represents the researchers comments at the time of coding. These comments were utilised in ensuring the dependability of the coding process, which is further discussed in Section 5.5.

This process of coding revealed three themes that were not accounted for in the themes present as part of the initial Philips framework, as shown in Figure 6. The data suggested evidence of friction between design and other disciplines caused by a lack of understanding, which was consistent with level 0 of creating a culture for design. Furthermore, themes of trust built through small design interventions and the creation of suitable spaces for innovation were consistent across multiple cases and could be categorised with level 2 of creating a culture for design. These themes were then added to the framework, which is visualised using bold text in Figure 8.

Expanding on the initial coding, a visual timeline of the three cases was created in order to determine whether it was possible to identify the way in which design's maturity developed over time. The first stage in achieving this was to create a timeline of the key stages involved in the integration of DLI across each of the three case studies. The results of this process are documented in Appendix F. Next, the data was mapped against the results of the initial coding process to determine whether instances of particular maturity levels could be mapped against incidents that occurred at specific times in each case. The results of this process are shown in Figure 9, which visualises the timescales involved as the maturity of design increases across each of the cases.

As a further example of the coding process, the remainder of this section will discuss the development of maturity of design as a capability within Organisation A, specifically in relation to creating a mature culture for design across the organisation. Prior to design’s initial introduction to the organisation (month 0 in Figure 9) , there was no awareness of the potential for design to create business value. Mark (p.8) discusses the way in which the engineering department were suspicious of marketing because of a poor preexisting funnel for new product development. Sales team members were instructing engineers to make products based on assumed client demands, however this process led to several unsuccessful projects and an inefficient allocation of resources. This suspicion lingered and impacted the initial introduction of design, which was seen as an extension to the marketing department and there was an underlying feeling that people didn’t know what they were doing and didn’t fully understand the needs of customers, leading to multiple project briefs changing without much notice to

the engineering team. Thus, engineers had no understanding of the potential of design to create business value, thinking of the discipline as merely an extension to a marketing team that had underperformed in the past.

As design was introduced to the organisation this awareness gradually increased, however, engineers still maintained the view that design was largely about improving aesthetics within the organisation and offered little outside of that domain. Subsequently, the introduction of the industrial design discipline was enough to transition the organisation from maturity level 0 to maturity level 1 (month 1 in Figure 9), whereby there is still little awareness of design's ability to add business value within certain disciplines, in particular engineering, however an appreciation of the discipline is beginning to grow in other areas such as marketing.

Month 9 of design's introduction saw the inception of a project that used design in order to explore new applications for an existing technology within the division, which stemmed from previous small successful projects that improved the aesthetics of the existing product range. This indicated a change from maturity level 1 to maturity level 2 in terms of creating a culture for design across the organisation. In launching this new project, awareness of design's potential to create business value was high across the organisation, stemming from previous successful projects combined with a communication strategy that aimed to disseminate the processes and value of design to other disciplines across the business.

Following this transition, culture for design remained at maturity level 2 for the rest of the study. Although design was beginning to create solutions at the operational level, it was yet to fully provide inspiration at the strategic level of the company in line with the definition of level 3, however a transition towards this state was occurring as the research closed. Subsequently, it could be expected that the organisation would reach level 3 in terms of creating a mature culture for design soon after the end of this research project.

	Maturity level 0: Understanding what design means to the organisation	Maturity level 1: Within function but in context	Maturity level 2: Integrated and aligned with other functions	Maturity level 3: Measurable impact on business result and performance
Design strategy	- Design strategy seen as a subset of marketing strategy. - Work out what a design strategy means for the organisation.	- Design strategy leads to design objectives, KPI's and improvement programs.	- Integral part of all short, medium and long term business objectives.	- Measurable influence on the long term vision and direction of the company.
Design programming	- Scoping the potential need/purpose of a design program.	- Design programs are derived from business programs. - Prioritisation based on business needs.	- Participation in business programming and road mapping leads to design programs. - Prioritisation based on potential return.	- Integral part of management decision process. - Measurable influence on the direction of business programmes
Design delivery	- Projects carried out in isolation.	- Design process defined. - Resourcing within the function. - Receiving design brief.	- Design process and resource planning integral part of business process and footprint business. - Ownership on briefing process	- Design delivery strategy based on measurable effectiveness and efficiency and supports future value creation.
Design to innovate	- Thinking about how design could be positioned alongside other organisation functions.	- Programmed contribution to innovation projects. - Aligned with innovation themes.	- Front end activities ensuring uptake. - Design as co-author of innovation roadmap and research themes, including front-end.	- Design and design thinking contributes to redefinition of existing markets and categories. - Pushing new paradigms e.g. ecosystems.
Design to differentiate	- Design understanding where it can improve the propositions offered by existing technologies.	- Contributing to the creation of management and orchestration of total brand touch points per category.	- Design facilitates the coherency of brand expression across all touch points.	- Design thinking contributes to defining the direction of the brand strategy and identity.
Design to optimise	- Understanding where design tools could fit within current processes.	- Contributing to simplifying and value engineering design solutions.	- Design facilitates the creation of optimising platforms, roadmaps and standardisation on a program level.	- Design thinking contributes to optimised processes, portfolios and value chain (end to end).
Design skills	- Identifying the design skills that are present within the organisation. - Understanding knowledge gaps that are present.	- Access to all design expertise's (comm. prod. serv…) - Talents identified - Job rotation within the organisational entity (sector)	- Internal and external expertise leveraged in projects. Succession planning leads to new design leaders. - Job rotation within the function (company).	- World class design expertise. - Talent management extending to partners and universities. - Design thought leadership recognised as benchmark.
Competence development	- Mapping out existing design competencies present within the organisation.	- Areas for best practice defined. - Relevant design information available and accessible.	- Internal and external collaboration increases competence and knowledge level. - Knowledge dissemination embedded in ways of working.	- Design competence recognised as benchmark - Design knowledge integrated in business knowledge management contributing to learning organisation.
Culture for design	- No awareness of the full potential of design in creating business value. - **Friction amongst design and other disciplines caused by lack of understanding.**	- Little awareness in the organisation on the full potential of design to create business value - Design seen as costs	- High awareness that investments in design are essential for NPS, brand equity and innovation. - **Trust built from small design interventions.** - **Creation of suitable working environment.**	- Design provides inspiration at a strategic level, while supporting direction setting and the creation of meaningful solutions on an operational level.

Figure 8: Philips framework with addition of themes from coding.

	Org/ Time	0	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36
Design strategy	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3
	B	0	0	0	0	0	0	0	0	0	0	1	1	2	2	2	2	2	2	2
	C	0	0	0	1	1	1	1	1	1	1	1								
Design programming	A	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2
	B	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
	C	0	0	1	2	2	2	2	2	2	2	2								
Design delivery	A	0	0	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	B	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
	C	0	0	0	1	1	1	1	1	2	2	2								
Design to innovate	A	0	0	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
	B	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3
	C	0	0	0	2	2	2	2	3	3	3	3								
Design to differentiate	A	0	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
	B	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	C	0	0	0	0	0	0	0	0	0	0	0								
Design to optimise	A	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	3
	B	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
	C	0	1	1	2	2	2	2	2	2	2	2								
Design skills	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
	B	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
	C	0	0	0	0	0	0	0	0	0	0	0								
Competence development	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
	B	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2
	C	0	0	0	0	0	0	0	0	0	0	0								
Culture for design	A	0	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	B	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2
	C	0	1	1	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2								

Figure 9: Maturity timeline for the three case studies.

5.4.3b Coding phase two

The initial approach to coding was followed by a second stage of coding, which utilised an inductive, grounded approach (Basit, 2003) with the aim of identifying barriers and enablers to DLI within each case. Tables 8 and 9 document the themes that emerged through this coding process, including a count of the instances in which each barrier or enabler occurred across each study. This process highlighted the barriers and enablers that were present across multiple cases, as well as those that were only applicable in one or two instances.

Barrier to design-led innovation	Occurrence in case study A	Occurrence in case study B	Occurrence in case study C
Lack of understanding/design seen as aesthetics	2	2	5
Risk adverse management with a cost focus	5	1	2
Contrasting attitudes	1	1	2
Structure of the organisation	9	2	1
Outdated software	1	0	0
Supply chain	2	2	0
Poor workspace design	2	0	0
Lack of agility	1	0	0
Risk of losing tacit knowledge	1	0	0
Fear of design causing job losses	3	1	0
Resistance to change	1	0	4
Poor communication skills	0	1	0

Table 8: Barriers to design-led innovation across the three case studies.

Enabler to design-led innovation	Occurrence in case study A	Occurrence in case study B	Occurrence in case study C
Change to physical working environment	5	1	1
Communicating design processes	10	3	1
Management understanding and support	4	4	1
Internal multidisciplinary collaboration	1	0	2
Organisational restructure	3	1	1

Demonstrating successes	4	1	1
Integration into organisational processes	1	2	1
Rewarding positive behaviours	1	0	0

Table 9: Enablers of design-led innovation across the three case studies.

Having identified the barriers and enablers to DLI through this process, it was then possible to map these factors onto the case timeline shown in Figure 9. The results of this process are shown in Appendix G. This process made it possible to determine whether particular barriers occurred at similar stages of integration within each of the three participating organisations, whilst also offering insight into whether the presence of enablers at particular points of integration had any effect on overcoming these barriers.

5.5 Ensuring the dependability of the analysis process

Krippendorff (2004) identifies three types of reliability that are necessary to consider within any analysis process, specifically in relation to establishing a reliable coding strategy. The first is stability, which is focused on whether a researcher's use of codes changes over time. Second is accuracy, whereby a coding scheme with high reliability is already established and alternative coding schemes are then developed and compared against it. Third is reproducibility across coders, which is often called inter-coder reliability, where the concern is in establishing that alternative researchers would code a dataset in the same way (Campbell *et al.*, 2013). This section considers the nuances surrounding the reliability and dependability of the coding process within this research study.

5.5.1 Establishing dependability within constructivist research

Coding a dataset manually, as it has been carried out within this thesis, is a subjective and interpretive process whereby the validity of the results become a question of hermeneutics as findings are interpreted and translated based on the position of the interpreter (Blair, 2015). This is particularly pertinent within a dataset collected under the influence of the constructivist paradigm, whereby researchers have tacit knowledge surrounding potential domains for inquiry, which can be invaluable in the interpretation of naturalistic data (Guba and Lincoln, 1985).

Within positivist research, inter-coder reliability is often cited as the critical issue in ensuring the reliability of the data analysis process. Inter-coder reliability refers to a

measure of agreement amongst multiple coders as for how codes are applied to a dataset (Kurasaki, 2000). Agreement between multiple coders can be utilised as a proxy for the validity of constructs that emerge throughout the analysis process, ensuring that themes generated through analysis equate to shared constructs (Ryan, 1999). Typically, inter-coder reliability is calculated by 'examining the degree to which coders agree across a fixed set of units', which are often predetermined (Kurasaki, 2000, p.180).

Conversely, within constructivist perspectives on qualitative research there is a need to consider the perspective of an individual researcher within the research process; particularly because a researcher's perspective evolves as they learn more about a context through experience and reflection (Harris *et al*., 2006). Data collected under the constructivist paradigm is understood to be collected as a collaborative act between researcher and informant, therefore multiple researchers would have differing perspectives on the collection and interpretation of the dataset (*ibid.*). Thus, within constructivist research, it is more appropriate to focus on the dependability[4] of the research findings as opposed to establishing inter-coder reliability. Specifically, this is because constructivist and relativist research paradigms focus more on the authenticity with which the individual researcher allows the data to speak, and less on the degree of agreement between multiple qualitative coders, where the value system of the researcher is an integral part of the research process (Nili *et al*., 2017).

Instead, Guba and Lincoln (1985, p.317) recommend stepwise replication or an inquiry audit as two potential methods for establishing dependability within a constructivist dataset, which seeks to ensure that any errors can be traced back to specific researcher error. Stepwise replication involves splitting a research team into two, with each subgroup studying the same context independently with frequent meetings to ensure coherency across the investigation (*ibid.*). This approach involves multiple researchers and as a result was outside of the scope of this study. Campbell *et al.* (2013) note that this is a common issue in checking the dependability of studies, whereby research is frequently carried out by researchers who are often the only principal investigator and whose budgets do not permit the hiring of a team of coders, which is often the case with young researchers at the beginning of their careers. The method has also been described as tiring and cumbersome in nature (Harris *et al*., 2006), which makes it difficult to correctly apply in a time frame consistent with that of this study.

[4] Constructivist research is deemed to be dependable if the study is capable of producing results where any variance can be traced to specific researcher error, shifts in perspectives of better research insights (Erlandson *et al.*, 1993).

Alternatively, an inquiry audit is a post-investigation audit that can be utilised to examine the process and product of research in order to ensure consistency across the analysis process (Hoepfl, 1997). Inquiry audits are enacted using materials collected during the study to ensure that the research process is capable of demonstrating that the interpretations made by the researchers were firmly grounded in the perspectives of the research informants (Erlandson *et al.*, 1993; Harris *et al.*, 2006). According to Sandelowski (1986) the findings of a study are capable of being audited when another researcher has the ability to follow the logic of the investigator as decisions are made throughout a study. An example of how this process could be achieved is provided by Koch (2006), who utilised the audit process in order to justify a dataset based on a constructivist approach to data collection. Guba and Lincoln (1989) argue that once an inquiry audit has successfully demonstrated the way in which interpretations have been arrived at within an inquiry, confirmability is then established. The inquiry audit was therefore deemed most relevant to ensuring dependability of the coding and analysis process utilised within this study.

5.5.2 Carrying out an inquiry audit to ensure dependability

Section 5.5.1 of this thesis established that an inquiry audit appeared to be the most suitable approach to establishing the dependability of the coding and analysis process in this particularly study. Specifically, because of the constructivist nature of data collection and the associated time and resource constraints surrounding the ability to conduct a dependability check. In order to carry out the inquiry audit of the coding techniques that were utilised within the analysis of this study, a peer review process appeared to be the most practical way of proceeding. To achieve this, two PhD students and a Research Associate agreed to take part in the inquiry audit.

Whilst the initial coding of the dataset was being carried out, the allocation of codes to statements was supplemented with descriptions that reflected the researcher's interpretation of the particular statement in relation to the analysis framework and the context in which the statement was intended. Appendix E contains examples of the tables that were derived through the coding process, with the final column highlighting examples of the statements that were created through this process.

In order to sufficiently carry out the audit process, a random selection of ten interview statements were provided to each of the three participants, along with the allocated code based on the Philips framework and a description explaining why each code was selected. The reviewers were then asked the following three questions to determine the extent to which they agreed with the code based on the available description: Do you agree with the code and description? Do you want to add anything? Do you want to change anything? The questions themselves were adapted based on the work of Birt *et*

al. (2016), who carried out a similar approach with research participants in order to validate their research approach. An example table from this peer review process is shown in Appendix H.

In reviewing the feedback, the reviewers agreed with the coding process to a large extent. Instances of disagreement occurred in two particular forms, disagreement surrounding the maturity level and disagreement surrounding the specific category from the Philips framework. Instances where the disagreement concerned the maturity level were rare, however it was necessary to review these codes in order to establish whether an error had been made within the initial coding process or whether a lack of contextual information led to the difference in opinions between the researcher and the peer reviewers.

Disagreements surrounding the category from the Philips framework appeared in instances where the reviewers felt that a code could be placed in multiple categories of the table as opposed to a single cell. This feedback led to a review of the coding strategy to ensure that statements appearing to cross boundaries between multiple types of design were given more than one code to appropriately reflect this information.

This review process was ultimately beneficial in ensuring the dependability of the coding strategy. Potential disagreements surrounding the maturity level of codes highlighted the importance of having the contextual information of each case, whilst it also meant that errors were detected and changed. Furthermore, the approach meant that the coding strategy was improved by highlighting statements that had potential to occur in multiple segments of the Philips framework.

5.6 Summary

This chapter began by outlining the necessity of having a theoretical framework through which the dataset could be viewed, before discussing the suitability of various maturity frameworks to act in this role. Having considered the benefits and drawbacks of four prominent maturity frameworks, it was decided that the Philips framework, developed by Gardien and Gilsing (2013), appeared to be the most appropriate for this particular study. Specifically, the development of the framework under conditions similar to those present in the case studies offered as part of this research was appealing, particularly focusing on a multinational organisation with innovation historically driven by science and technology. Furthermore, the framework offered a significant level of detail when compared to the alternatives; thus further increasing the appeal of the framework to act as a lens through which the data could be viewed.

The primary limitation in utilising the original Philips framework is that it does not consider the early integration of design as a discipline into organisations, particularly in instances where a design function is not already in some form of existence. To overcome this, adaptations were made based on the work of Aftab (2013) who provided a detailed timeline of projects prior to the inception of the framework that made it possible to extrapolate the framework and create a ‘maturity level 0’ column that focused on the way in which Philips set about understanding what the use of design meant to innovation within the organisation.

Two stages of coding were then carried out using the Philips framework as a guide. The first stage allowed the data to be categorised based on the application of design as well as the level of maturity in which it was being utilised. This process informed the creation of project timelines for each of the three cases, which visualise the way in which design’s maturity increased over time based on critical incidents that occurred as it was introduced to the organisation’s innovation practices. The second stage of coding identified barriers and enablers to DLI that both inhibited and supported DLI across each of the cases. It was then possible to map these barriers and enablers against the timeline created through the initial coding to determine how the presence of barriers and enablers to DLI changed over time. Finally an inquiry audit process was carried out in order to ensure the dependability of the coding strategy, which strengthens the theoretical propositions derived throughout the research process. The following chapter will discuss the findings from this process, by outlining the way in which design was integrated across each of the three case studies.

6.0 Findings from case study activity

The purpose of this chapter is to outline the way in which design has been integrated across each of the three case studies. This will be presented in a narrative format in order to accurately present the reader with the context of each case. The findings are presented in a chronological order that covers the timespan of design activity within each setting, based on the critical incidents derived through the analysis process, which were discussed in Section 5.4 and are outlined in Appendix F. The narrative is informed by the findings of the semi-structured interviews within each organisation and presents the data in a way that reflects the initial findings from the three case studies.

6.1 Presentation of data

In order to provide an accurate description of each case, the interview transcripts have been used to construct a narrative that answers several questions about each organisation, relevant to answering the initial research question of ‘how do science and technology-led organisations adopt design-led approaches to innovation?’. Initially a background to each organisation is provided to inform the reader of the operating environment of each company. Subsequently, the question ‘why implement a design-led approach to innovation?’ is asked. The answers to this question build on the operating environment of the organisation to consider the previous state of innovation within the company and the extent to which design was used previously, if at all. It aims to cover the circumstances that led the company to initially express interest in DLI and begin to consider how it could fit into existing innovation processes.

Next, the question ‘how was design implemented?’ is asked. This question aims to cover the circumstances surrounding the implementation of DLI over the course of the study. In this section, critical incidents are discussed highlighting key phases of the design integration process from the viewpoint of the participants. Where possible, this section has been detailed in chronological order to ensure fluency of reading and to give the reader an understanding of how design has developed over time.

The narrative then aims to consider the impact that design has made on the organisation over the course of integration, in order to establish an up-to-date viewpoint on the integration of the discipline into organisational processes.

Finally, cultural barriers to DLI within each organisation are considered. Whilst the background section provided an insight into the wider operating environment of each case, a deeper understanding of cultural factors surrounding the implementation of design within each case needs to be considered. Each case has a specific set of cultural factors that underpin the decision making process of the company at various

stages of the integration process and it is important to try to contextualise these decisions within the wider cultural context of each study. The relative size of each organisation presents a series of challenges in understanding the culture at the operational level, which is underpinned by Meschi and Rodger (1994) who note that if an organisation develops into a multinational conglomerate, the culture of the headquarters is likely to influence the culture of subordinates abroad. Hofstede and Hofstede (2005), reveal further insights suggesting that organisations may be culturally divided based on several factors including hierarchical levels, functional areas, country of operations and being a former merger partner (Figure 10). Each of the three organisations is constructed differently in terms of the hierarchical layout of the company and as a result the cultural insights section aims to identify factors that stem from the top management of the organisation as well as those that are relevant at a more localised level.

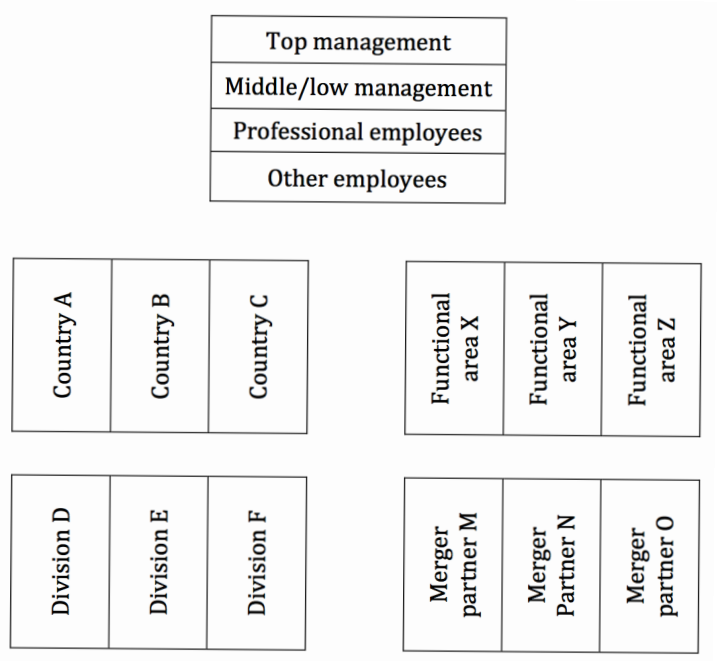


Figure 10: Potential subdivisions of an organisation's culture (Hofstede and Hofstede, 2005, p.311).

6.2 Organisation A

6.2.1 Background

Organisation A is a Fortune 500 US manufacturing company which specialises in engineering, focusing on the creation of a variety of products that range from motion control technologies to industrial filtration (Mark, p.1). The organisation has an annual turnover of over $10 billion, with a large proportion of this being generated through business to business sales (Isaac, p.1). Globally, the organisation employs over 50,000 people across the world in most major countries (Mark, p.1).

This case study focuses on a specific division which operates within the larger organisation, located in the UK. The division itself is part of a wider group that specialises in filtration products that have various industrial applications ranging from industrial driers to soft drink dispensers, with the group being responsible for $1.5 billion of the organisation's total turnover (Mark, p.1). Originally the particular division was a separate company before being acquired in 2006 by the global group. The structure of the organisation is such that each division is given a large degree of autonomy and as a result the division has its own decentralised management structure, with marketing and engineering leading the way in terms of industrial design's introduction to the organisation's innovation processes (Mark, p.1).

6.2.2 Why implement a design-led approach to innovation?

Organisation A has particularly strong capabilities in developing technologies, meaning that new products are typically the most technologically advanced on the market, capable of delivering great performance; however this has led to the creation of expensive products that were often undercut by competitors entering the market space (Sarah, p.1). A lack of a strategic roadmap or the creation of tiers for product offerings made it difficult to ensure that new products would live up to their potential in the marketplace, with customers often favouring the cheaper alternatives offered by competitors. The lack of strategic planning surrounding new projects was highlighted by conversations in the canteen where people were asking others to carry out work on particular innovation projects in exchange for a sausage sandwich (Sarah, p.3), as opposed to a rigorous innovation process in place to exploit the opportunities best suited to the organisation. This type of thinking led to stagnation within the firm, where people weren't actively pursuing new opportunities within the marketplace (Sarah, p. 13).

Furthermore, the previous structure of the division meant that sales managers were the primary point of contact between the organisation and its customers. Typically these managers were located out in the field and were measured on their performance in ways that made them less likely to share knowledge and intelligence from their particular customers in order to protect their relationships (Isaac, p.8). According to Isaac (p.8) the sales team would ask clients what they wanted and would return to the marketing department with a brief and a deadline by which a new product would be needed. Based on the value of the project, the work would then be allocated resources in the work stream to hit the specification with no one questioning the requirements (Isaac, p.8). Paul (p.2) compared the process to the game of Chinese Whispers where customers might say exactly what they want but by the time the message is passed through various teams from the initial contact with the sales managers, the engineering

team would be producing things that do not fit with what the customer originally wanted. This led to issues where new products were being created without the necessary input from customers, meaning that often products were overpriced or concentrated on issues that were not at the core of the customer's initial need. Furthermore, sales managers often requested certain products before later changing their demands and asking for different features, resulting in a situation where engineers were overloaded with projects and mostly unsuccessful in their delivery because they couldn't effectively allocate resources and focus on issues that were critical for the customers (Mark, p.8). These problems were primarily created through organisational structural issues, compounded by a lack of understanding surrounding the correct innovation process.

The organisation also faced issues surrounding human resource allocation, with sales staff promoted to roles that they weren't necessarily qualified for. Sarah (p.14) stated that people ended up as business managers or product managers (in the sales team) having previously been trained in engineering, quality assurance and testing. Not everyone that made this transition had the right mindset for sales, in that they may not be comfortable picking up the phone quite often or have the social skills required in order to be successful sales people. Ultimately these people weren't working in a place which is in their comfort zone and as a result they were not very good at it (Sarah, p. 14). These factors resulted in the division generally underperforming within the marketplace. Furthermore, the division didn't match up when measuring themselves against other divisions from the wider organisational group, with divisions in Germany and Italy launching products much faster (Sarah, p.12). Thus, it was taking longer to get products to market and the products that were created were not appealing enough to a wider customer base. Ultimately a desire to remedy this situation led to the introduction of industrial design practices within the organisation.

6.2.3 How was design initially implemented?

Sparked by the underperformance of the division, the division marketing manager sought to engage design in order to help refresh the look and feel of the organisation's current product offerings. Many of the products that were being manufactured had been in production for over twenty years and still held on to the old branding that was used before the company was acquired; alongside attempts to incorporate the newer branding (Sarah, p.1-2). On the whole, this led to a confused set of product lines that didn't necessarily reflect the new organisation, whilst also being confusing to potential and existing customers. Subsequently, the firm commissioned a project in which staff of Northumbria University were provided with a brief to investigate the aesthetics of an existing product as well as investigating the semantics behind parts of the product (Sarah, p.2).

Internally, this proved to be an interesting and successful piece of work, which led to the commissioning of an additional project in which the brief was to harmonise branding across the entire suite of products in order to create a consistent family feel across the product range (Isaac, p.7). This faced resistance from many of the longer-serving workers who were tied to the old colour scheme which reflected the original organisation, however the project continued and a new visualisation of the product range was created. A thorough piece of work was then carried out in order to determine whether this change in branding would be looked upon favourably by customers and the reaction was overwhelmingly positive (Sarah, p.2). Subsequently the branding change was then rolled out across the entire product range.

Upon completion of this work, representatives from the University explained to the organisation that design could be better used in helping the organisation to innovate with a more customer-centric approach, as opposed to a tool that is only used to generate stronger visual communication. The organisation agreed which resulted in the creation of a Knowledge Transfer Partnership (KTP, see page 13) in which a student from Northumbria was embedded within the organisation for a period of two years and supported by academic advisors from the University (Mark, p.7). Using design in this way was a completely new capability to the organisation and over a two year time span, the KTP Associate and advisors from the University carried out a range of projects that strived to help the organisation develop a more systematic way of understanding customer needs and, as a result, generate more meaningful products.

Early in the KTP, members of the organisation weren't fully aware of the business value offered by design and primarily aimed to utilise the designer on activities involving the visual aspects of products. Isaac (p.3) offers an example of this describing an occasion when he was asked to design a fascia for a product containing two columns that had been designed by an engineer. In this instance, Isaac felt that the final product would have benefitted from a design that contained an extra column that would have allowed a unified feel across product ranges and also would have produced cost savings. Subsequently, the designer had been brought into the project too late to have a meaningful effect on the final product outside of minor visual changes.

Over time, the involvement of the industrial designer led to a customer-centric design approach that was embedded at the core of the new product development process, including projects that sought to redefine existing technologies in order to suit new market opportunities. One specific project acted as a testing project to pilot the new approach and saw the designer engage with a potential product area surrounding soft drink dispensing. This involved the designer carrying out a range of activities including the creation of processes and toolkits in order to achieve the project brief (Isaac, p.7).

This utilised design to build on an existing product capability within the organisation in order to create a new product opportunity for the division. Much of the value in this project involved the interaction with customers in order to fully understand the marketplace and position the company so that it could actively respond to the new market opportunity.

Whilst design was progressing at the operational level, strategic changes were also occurring within the organisation. The work was beginning to be acknowledged by senior Vice Presidents within the organisation, with the Vice President of Innovation (based in the US headquarters) in particular taking a keen interest in the work (Sarah, p.9). The support of the Vice President of Innovation acted as a catalyst for the marketing manager to acquire a budget to transform the workspace within the offices. Mark (p.5) noted that it was initially difficult to acquire funds at the location level of the firm, however input from the Vice President of Innovation made the senior management of the division agree to releasing funds to redesign the office space of the UK division in order to create an area that was more conductive to carrying out team-based projects in order for the design-led approach to thrive within the organisation. This led to the creation of a dedicated space for innovation, available to staff whenever they wanted to use it (Isaac, p.2). The space itself was equipped with a large whiteboard, computer and plenty of resources to facilitate brainstorming activities and acted as a visual signpost that the company was beginning to think about design (Isaac, p.2). The space was also significant in that it acted as a visual indicator of the organisational change process, demonstrating that the integration of design is something that the company were invested in for the long-term. The space itself acted as an area to encourage people to think about new ideas for products, but also create concepts that could stand up to scrutiny from various areas of the business in order to be commercially viable (Emma, p.8). Figures 11 and 112 show the completed innovation space.

Figure 11: External view of the innovation space.

Figure 12: Internal view of the innovation space.

Acknowledgement at the Vice President level also initiated conversations between the division and other divisions within the strategic group as to how they could develop design capabilities across the larger group. In part, this recognition occurred from the division winning internal innovation awards within the organisation (Paul, p.8), where products are rated on a yearly basis based on their sales revenue and success on a wider scale. Subsequently, increased recognition led to smaller projects being carried out for other divisions so that they can get a feel for what design is offering within the UK division and how they are integrating it into innovation processes (Emma, p.4-5). Emma (p.5) also highlighted that support from the Vice President of Innovation would also be critical in expanding the design capabilities beyond the European division and into the American division; something that would be necessary in order for design to gain a strategic foothold within the organisation.

6.2.4 What impact has design had?

Upon completion of the KTP, the associate was offered a full time position within the organisation and continued to add industrial design input to the organisation's innovation projects. At the time of writing, as well as attracting attention from senior figures within the organisation, other divisions have asked for guidance in adopting similar approaches to innovation within their own practices demonstrating an increased desire to incorporate design across the wider organisation. Within the division, several more product initiatives are about to reach the market, with the success of those products likely to determine whether the organisation increases the capacity of design in the immediate future.

There has also been a conscious effort to map design against the organisation's existing innovation processes in order to ensure that design is fully integrated and able to act at the front end of innovation, as opposed to coming in at the end of projects and adding a visual refresh like it had been used previously. Traditionally, the organisation has adopted a formal Stage-Gate process to innovation (Cooper, 1990), with five separate stages in place to launch new products. Upon completion of the KTP, the benefits of design to the division have been acknowledged by management and efforts have been made to map industrial design against the previous Stage-Gate innovation process of the organisation (Emma, p.14). Layering design on top of the Stage-Gate process in this way has meant that design is now seen as being active at the front end of new projects by all members of the division, meaning that the industrial designer spends time understanding the customer when new projects arise before having an input into brainstorming as well as the final form of new products (Mark, p.2).

6.2.5 Cultural barriers to design-led innovation

6.2.5a Autonomy of the division

The wider structure of Organisation A presents a complex environment in which to understand the culture of the specific division at the focal point of this case. The division itself operates with a degree of autonomy in terms of decision making at the operational level. Prior to the introduction of an industrial design capability, this resulted in a localised culture quite similar to that of the larger organisation. In part this stemmed from similarities in processes between the division prior to its acquisition and the parent company once it had been acquired. Paul (p.1) notes that a Stage-Gate process had been used prior to acquisition by the parent company in the creation of new products for the organisation, with seven stages being in place before a concept was ready for production. Upon acquisition, a similar process was integrated by the parent company, with the stages being reduced to five from concept to launch however according to Paul (p.2) the new process was more formal at each stage. This has resulted in more projects being turned down, in part due to business reasons but it has also developed a culture of being risk adverse in the innovation process. Isaac (p.4) highlights that this has been an occurrence with other functions of the business such as R&D, who have also had projects cancelled because they have cost implications and have been viewed as too risky. Emma (p.6) echoes claims that the organisation is risk adverse and underpins this viewpoint by explaining that the organisation is more likely to acquire technologies that have an existing degree of success than develop a new technology through product development.

6.2.5b Risk adverse attitudes

The risk averse nature of the organisation has conflicted with the integration of design, where risk taking is an essential part of the innovation process. In particular Paul (p.5) highlights that brainstorming sessions have been difficult as people are quite often viewing ideas negatively with phrases such as ‘well that won’t work’ and ‘you can’t say that’ being frequently used in discussions. As the influence of design has increased within the organisation, it has also been seen as a tool for de-risking new product ideas. Isaac (p.4) has found that the company is still quite risk adverse despite the introduction of industrial design capabilities, however Mark (p.5) highlights that using design at the front end of innovation projects has resulted in customer validation of ideas up front in the ideas and concept generation stage of the innovation process, allowing some of the more unusual concepts to make it through the decision making process when previously they would have been criticised early on from other areas of the business. Thus the overall attitudes towards risk may be similar however the ability of design to communicate business value within the organisation has clearly increased.

6.2.5c Fear of job losses

Some of the hesitancy from people to engage with brainstorming has also been mentioned in relation to the engineering team engaging with the design process. Emma (p.3 & 11) highlights that members of the engineering team were hesitant to engage with design initially due to a fear that design would take over parts of the engineering role that people enjoyed carrying out on a day to day basis. Emma (p.11) has also noticed a similar resistance from members of the marketing team who have been generally dealing with customer opinions in the past and have had this responsibility reduced since the integration of design. Sarah (p.11) recalls instances where specific engineers were very resistant in the brainstorming process, citing negative body language and a reluctance to engage as particularly difficult to manage. There was a visible split between people who were on board with the process and those who were not (Sarah, p.11). Over time, Emma (p.11) felt that the resistance from engineers has declined. In part this stemmed from reassurance over job safety and acknowledgement that the engineers would still be carrying out tasks that they had enjoyed previously (Emma, p. 11). Furthermore, constant communication about the work that the industrial designer was carrying out helped to communicate the value that design was offering outside of the work that was done previously which helped staff at both the operational level and management level understand the value of the work being carried out (Emma, p.11; Mark, p.10).

6.2.6 Summary of activity in Organisation A

In carrying out this case study five semi-structured interviews were conducted, each lasting approximately an hour with the longest lasting one hour fifteen minutes. The people at the heart of integrating DLI within the organisation were questioned with the aim of understanding how industrial design was integrated at the operational level of an organisation to the point that it was gaining traction with senior decision makers. Over the period of the work, several key projects were identified as being crucial to this process, with the redesign of product branding providing the initial foundation for design within the organisation. Subsequent projects surrounding a customer-focused approach to innovation led to senior management acknowledging that DLI is a valuable tool to the organisation and was rewarded with investment to create an ‘innovation’ space capable of facilitating the work at a divisional level. The findings also demonstrate the change in culture surrounding design following successful projects, with initial fears surrounding job losses and misconceptions surrounding the purpose of design being common at the beginning of the work; however the extent to which they were present at the end of the research had diminished. Similarly, an attitude change from members of the division has been demonstrated with the perspective to design and risk changing over time, from design being seen as a risky strategy to design being seen as a tool for managing risk within the innovation process.

6.3 Organisation B

6.3.1 Background

Organisation B is a global fast moving consumer goods company that has a portfolio of over four hundred brands. The brand portfolio is broadly spread across several categories including food and drink, home care and personal care, with multiple brands being classified as leaders in their respective markets. The company places innovation at the heart of its growth ambitions, particularly in the areas of science, technology and product development. This case study focuses specifically on the organisation's attempt to understand its existing design capabilities and build the influence of the design function so that it is able to have a greater effect on the organisation's strategic level operations. It achieves this by focusing on the design capability team of the organisation at the strategic level, as well as looking at the impact that design has at an individual brand level through the lens of a project undertaken by a home care brand.

The home care brand itself is well established, having been initially created in the 1920s and turned into a leading home care brand within retail outlets during the 1950s. The project involved two distinct phases, the first of which aimed to generally reduce the packaging of the product, whilst the second phase aimed to cut the costs associated with the product by 50%. Design played a larger role within the second phase of this particular project, therefore references to the project will be focusing on design's impact in attempts to reduce the costs associated with the product by 50%.

6.3.2 Why and how was design-led innovation implemented?

The organisation itself went through a restructure in 2013, in which twelve product categories were combined into four larger categories, with the goal of reducing the number of Senior Vice Presidents from twelve down to four (Chris, p.2). Each of the four large categories was then assigned several subcategories as highlighted in Figure 13. Ultimately this organisational restructure presented an opportunity to change the way that design had worked within the organisation. Initially the design resource of the firm was assigned to each of the twelve categories, which meant that the design resource of the organisation was spread thin (Chris, p.2). Following the restructure, each of the four major categories were assigned their own design resource and a Design Director was appointed by the Vice President of Packaging with the view of overseeing each of the design teams across the four categories.

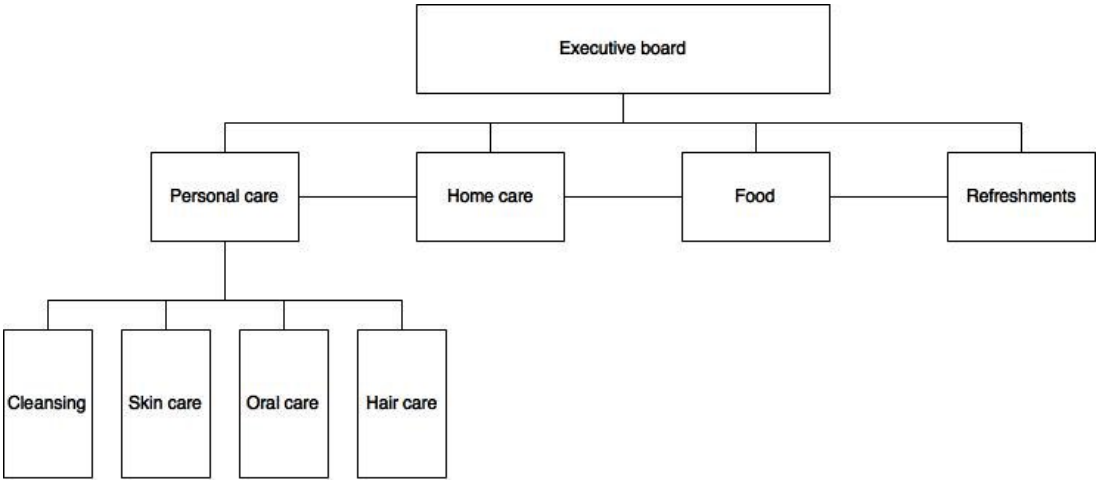


Figure 13: Organisation B indicative hierarchy diagram.

Upon his hiring, the Design Director was tasked with conducting a piece of work that evaluated the performance of design within the organisation, specifically looking at why design should exist within the company and what it should be delivering (Chris, p.2). This work was ongoing for a period of a year and a half, however the Vice President of Packaging was unsatisfied with the outcomes from the work and felt frustration that the Design Director appeared unable to influence, convince or demonstrate what design was doing within the organisation. As a result, the Vice President of Packaging decided to change the job entirely and a new role was created in which the focus was a similar task but with a much larger scope. In particular, the role was looking at why designers should be present within the organisation, what they are going to deliver and also what value it would add to the business (Chris, p.2). This work led to recognition that design needed to take up several forms within the organisation in order to influence decisions within it, in particular design for experience, design for strategy, design for leadership and design for engineering were identified as key areas that design needed to deliver within the organisation. There was clarity surrounding the role of design for experiences, however the other areas were thought to be missing and the organisation set about looking at how design could deliver clarity within these areas across the organisation (Chris, p.1).

Within the home care project, design was given an influential role in facilitating a workshop that aimed to take a multidisciplinary approach to solve the problem of reducing product costs by 50%. The workshop was facilitated by Northumbria University in collaboration with an external design consultant and involved a day of activities aimed at solving this business problem. The morning session involved presentations from various members of the organisation in which numerous

perspectives were discussed in relation to solving the problem at hand. The afternoon involved multiple ideation sessions that had the aim of scoping opportunities for the brand through multidisciplinary problem solving in an attempt to derive radical solutions that could be utilised in reducing the costs associated with the product by 50%. As well as facilitating the workshop, design acted in a thought provoking role by offering solutions to the problem that would be seen as radical by members of the project team in an attempt to persuade other members of the organisation to come up with ideas that aren't initially inspired by streams of data (Penny, p.8).

6.3.3 What impact has design had?

Strategically, design is under the control of category directors, which means that there is still not a consistent design function that operates across the entire organisation. In one extreme example, the oral care category does not have a single designer, whereas the best case scenario is the laundry category that has twelve designers (Chris, p.5). The position of twelve designers within the laundry category highlights that design is valued by that particular category director however this opinion is not shared by the director of the oral care function. Chris (p.5) highlights that there is a belief amongst packaging directors that design is a good thing but not essential and that there are other priorities above design resource, thus the organisation still has some way to go before design is influential at the category level.

There are however examples of design building influence, particularly amongst the marketing function. Penny (p.5) recalls a particular piece of work regarding experience maps that gained significant traction with the marketing function. To make the map successful, data from the marketing function was necessary, therefore a collaborative effort was needed in order to create a piece of work that the marketing function viewed as both valuable and reliable in the way that it accurately depicts the experiences of consumers. The traction of this work can also be viewed at the strategic level, in which Chris (p.1) identified design for experiences as an area that is both at the core of the design function and a strategic capability that the organisation currently possesses.

At the brand level, the organisation is struggling to push through phase two of the home care project (Penny, p.2). The initial workshop provided a lot of stimuli that was necessary to achieve the desired cost reductions associated with the product, however the organisation struggled to put in place a strategy that utilised these stimuli effectively. Penny (p.7-8) claims that the team in charge of delivering the project had not yet created a roadmap that would be necessary in order to take the project forwards and as a result the design team decided to wait until this roadmap was developed before offering insights as to how the project should progress. In this instance, the design team has deliberately decided to step back from a leadership role

in the hope that the project team will step up and make the necessary decisions to drive the project forward.

6.3.4 Cultural barriers to design-led innovation

6.3.4a Strategy

Organisation B provides a strong public message that it aims to operate in a sustainable manner, reducing the environmental impact that the company has whilst continuing to grow its business operations. This message is also strongly echoed internally, with Chris (p.1) noting that the strategic direction of the design capabilities team in particular is closely aligned with the message that the company projects externally. Despite this, it appears that there is a disconnect between the message from the CEO and the desire of brand managers to achieve profits, alongside a general lack of knowledge as to how sustainability could be implemented across the organisation.

Penny (p. 7) highlighted a specific part of the home care project that had the aim of solving a particular problem in the most environmentally friendly way, by looking at how a circular economy[5] approach could be taken. Within the workshop there was a significant amount of time to think about how a service or product could be created in line with a circular economy approach and also in line with value for consumers. Initially, the project brief was a blank slate regarding the circular economy, however there was a consensus amongst the design team that the project team didn't fully appreciate the efforts necessary in order to fully implement a circular approach (Penny, p.7). Penny (p.7) notes that people didn't appear to understand a video that was designed to evoke reactions surrounding a service based concept that was fully circular. The notion of creating a service as opposed to a product seemed crazy to the project team and Penny (p.7) felt that they didn't understand that this type of thinking is required in order to solve the problems that they are trying to solve.

Ultimately, there is evidence that there is an unwillingness to take risks that would lead to radical changes in the market, even in instances where there is potential to have a substantial impact on the environmental footprint of the organisation. This unwillingness appears to be down to a lack of knowledge surrounding the types of solutions that are necessary in order to effect the environmental impact of the organisation in the way that the CEO has described whilst still offering value to the end

[5] A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life (WRAP, 2017).

consumer. Similarly, this has been seen at the strategic level of the organisation, in which Chris (p.3) notes that the overall strategy has not yet percolated enough into marketing within the organisation and that only a few people have an awareness of the strategy and the extent of its importance to the direction of the company.

6.3.4b Relationship between design and marketing

Chris (p. 3) describes Organisation B as an organisation that is marketing led but supply chain restricted. Subsequently, marketing believe that they rule what happens within the company but as a matter of fact it is supply chain that dictates a lot' (Chris, p. 3). The company is acknowledging the dominance of supply chain by acquiring new businesses in an attempt to push agility on the supply side, however the dominance of marketing is more difficult to address. There is a feeling from marketing that Research and Development is seen as engineering and not necessarily as research and therefore marketing does not see research as a directional capability within the organisation (Chris, p.3). As a result, there is a prominent belief within marketing that everything comes from an insight and as a result the company are reluctant to pursue technological possibilities unless they can immediately identify a group of users that the new technology would benefit (Chris, p.3).

On an operational level, it was also possible to gain an understanding of the influence that marketing has across the organisation. Within the workshop, several people would come up with ideas before the conversation turned to whether the ideas would be appealing to the marketing function of the organisation. Penny (p. 11) notes that 'people were strict about new possible routes to take with ideas, since marketing wouldn't approve packaging changes or changes to the structure of the product.' The viewpoint of the designer is very much 'we are not forced to stay in the same place just because we are winning today' (Penny, p.11), whereas the marketing viewpoint is that there is no need to deviate away from something that is already successful in the marketplace as it is an unnecessary risk to the brand (Chris, p.3). Chris (p.3) highlights that this disconnect is partly caused by a lack of communication skills from within research and development, in which people do not know how to communicate the benefits of new science or technology to the marketing department. In particular, there is a disconnect between the creation of science or technology propositions and the communication of these propositions using language or graphics that are capable of narrating the benefits that the new technology can offer to consumers.

6.3.4c Job rotation policy

In addition to the dominance of marketing within the organisation, the organisation has a strict job rotation policy that also effects the diffusion of DLI across the organisation.

The general rule within the company is that every three years, people within research and development should begin to think about changing jobs. Additionally, within marketing, people are encouraged to change jobs after only eighteen months (Chris, p. 3). This leads to multiple issues surrounding the ability of designers to convince other disciplines of the business value that design can offer. Projects within the company are initiated by brand managers, who will have the final say on whether design can begin projects. It is often the case that design has to convince these brand managers that they should be allowed permission to carry out projects, however it is often the case that the brand manager is then moved on to another position midway through the project. When this happens, the design team then have to convince the new brand manager that they should be allowed to continue working on the project, particularly if the new brand manager also has limited experience of design processes across the organisation (Chris, p.3). Subsequently, design is then in a position where it has to convince another person as to its benefits in terms of adding value in order to continue working on a project, which is detrimental to the integration of design across the organisation.

6.3.4d Fear of design making other functions look bad

Chris (p.5) also highlights an instance in which one of the categories hired a designer for the first time after having no dedicated design resource. The work carried out by the designer was described as ‘amazing’ in that she was perfect for the role and communicated effectively with the marketing function better than it did with the packaging function. She was very effective in the roles that she carried out, however she moved roles after three years and they haven’t back filled the position. The reasoning behind this was that she made the packaging team so uncomfortable because she was doing things that they should have been doing and she was making them look bad as a function (Chris, p.5). Subsequently, the packaging team maintained an attitude that design just gets in the way of the work that they are trying to carry out. Interestingly, the packaging team had packaging engineers who were initially trained in design and these people have been starting to align themselves with the design capability of the organisation, however it is very much subservient to packaging in that particular circumstance.

6.3.5 Summary of activity in Organisation B

The data for this case study was collected through two semi-structured interviews with a practicing designer and a design practice capability manager, lasting an hour and a quarter, and one hour respectively. Additionally access was provided to the day-long workshop centred around solving the problem associated with the home care brand. The case provides the perspective of design integration from two perspectives, the

perspective of a capability manager responsible for understanding the bigger picture of how design can influence strategic decision making as well as the perspective of a practicing designer who is focused on the way in which design can influence decision making within projects at the brand level. The findings explore the change in perspective surrounding design at the strategic level and note the cultural issues that are still present within the organisation and having an effect on the future development of the design function at both the strategic and operational levels. In particular, the relationship between design and other disciplines is important as the company has traditionally been dominated by the marketing function and the key to future growth is dependent on how the relationship between design and marketing evolves.

6.4 Organisation C

6.4.1 Background

Organisation C is a Chinese based manufacturing company that owns (either fully or has majority shareholdings in) 46 subsidiaries across the globe, with over 180,000 employees. Organisation C also ranks in the top 100 of the World Top 2500 R&D Investors list. This case study focuses specifically on one of the subsidiaries owned by the larger corporation. The subsidiary itself is one of the leading manufacturers of remote intervention equipment that is capable of being operated in hazardous environments world wide and was classified as a large business before its acquisition. The company has built a reputation in subsea engineering, in particular producing remotely operated vehicles that are capable of carrying out oil and gas related activities directly on the seabed. Organisation C has a decentralised management structure, however it regularly reports to the Chinese ownership who have a tight control over budgets.

6.4.2 Why implement a design-led approach to innovation?

Much of the traditional success of the company is based on being an engineering-led organisation that encouraged the recruitment of high calibre engineers that were capable of solving the problems that faced the organisation (Harry, p.2). Traditionally, customers would approach the organisation with a specific brief for a product or part and then the organisation would create something based on the specification that they are provided (Philip i2, p.4). More recently, however, declining oil prices have led to a decline in the market for subsea resources (Philip i1, p.1). Subsequently fewer clients have been approaching the organisation with requests for products. Furthermore, clients are becoming more cost aware and safety conscious, which has led a move into autonomous technology (Peter, p.2), which the company was not adequately prepared for. This has meant that the previously successful approach to solving problems

through engineering excellence was not compatible with the newer problems facing the organisation and the organisation began to investigate whether design might have a role in the strategic thinking of the organisation as it attempts to deal with the challenges it now faces (Harry, p.2).

6.4.3 How was design initially implemented?

Upon deciding that design could impact the way in which the organisation innovates, Organisation C hired an industrial designer and an external design consultant, as well as seeking help from Northumbria University in order to set up a pilot project that had a brief surrounding the redesign of an existing product area so that design could be evaluated on its ability to add value to existing business revenue streams (Harry, p.2). This project involved the redesign of a control cabin for an autonomous subsea vehicle and extensive research was carried out in order to understand the experiences of the workers responsible for piloting the subsea vehicles. User experience mapping in particular played an important role in the work, with Figure 14 showing a map that aimed to identify parts of the control cabin that pilots were satisfied and dissatisfied with based on their experiences operating the subsea vehicles.

Figure 14: Control cabin project - User experience mapping.

The project concluded with a prototype unit being created in the car park of the office, which aimed to map out what the environment of a newly designed cabin might look like, however the business felt that the value stemming from the project was primarily in the approach that was taken throughout the project rather than the final outcome (Harry, p.2). Claire (i1, p.2) highlights that the process utilised throughout the project was fed back to the strategic leadership team and from there many of the senior stakeholders saw the potential of design to impact the innovation processes of the

organisation. Subsequently, the design consultancy and Northumbria University team was tasked with a brief to investigate what autonomous vehicles could mean for the company, what technology gaps are present and how the company could deliver in these areas (Peter, p.1).

This led to a strand of work that focused on the business opportunities surrounding autonomous technology (Claire i2, p.1). The first stage of this work involved system mapping of the current processes within the organisation in order to benchmark the existing operating processes, with a view to understand the time and cost implication of changes to the innovation process with respect to dealing with the challenges facing the organisation surrounding the market trend towards automation (Claire i2, p1). From this mapping, several areas were pinpointed as 'friction points', in which problems were detected within the existing innovation process in relation to meeting future challenges. This allowed the team to identify capabilities that the organisation needed in order to progress in the area (Claire i2, p.1). Ultimately, the project led to a presentation that was pitched as three categories of work including opportunities for the organisation to exploit now, opportunities that the organisation could exploit in the future and the capabilities that need to be developed in order to be in a position to successfully exploit the opportunities (Claire i2, p.1).

6.4.4 What impact has design had?

Following the identification of opportunity spaces in the project, the organisation is now trying to concentrate on understanding how they can position themselves so that they are able to meet these opportunities with new product and service offerings (Philip i2, p.1). The project itself was seen as a success by members of the leadership team in that they have been provided with a framework and process to create strategic value and plan ahead; thinking about how they can strengthen the business in the future by running opportunities through this framework that would then be capable of facilitating the creation of a range of product concepts capable of being developed by the firm (Claire, i2, p.2). In the short term, the organisation is aiming to pinpoint a minimum viable R&D project that could be done utilising the new framework so that they have something tangible, capable of reinforcing the value provided by the new process (Philip i2, p.1). Furthermore, the directors of the organisation have seen the value in the project and are willing to provide the budget and necessary resources required to make this happen (Philip i2, p.1).

6.4.5 Cultural barriers to design-led innovation

6.4.5a Resistance to change

One of the biggest cultural barriers to the implementation of DLI within Organisation C has been resistance to change from middle management within the organisation, particularly with the engineering staff. The organisation views itself as a progressive, developmental organisation however the activities that they carry out don't necessarily align with this viewpoint (Philip i2, p.1). In particular, the organisation does not carry out R&D as a full time exercise so barriers have been in place in terms of convincing people to change their way of thinking surrounding innovation (Philip i2, p.1). In instances where engineers have been involved with the concept mapping activities associated with the project, the engineers have had a mindset that their job is to optimise things that they are already doing as opposed to exploring new opportunities for the business (Claire i2, p.4). In this respect, the engineers were primarily concerned with the problems that are typically put in front of them, whereas the management of the organisation are trying to position design strategically so that it can be proactive in scoping the needs of customers before the customer identifies their own problems (Claire i2, p.4).

There is also confusion surrounding the term innovation within the firm, particularly between the engineers and the design team. The engineers view the work that they do as innovative, in that they are deriving innovative solutions to problems within their own space of product improvement, whereas the design team are talking about innovation in a different way, specifically looking at how the business model of the company can be improved so that they are reactive in pursuing new opportunities (Claire i2, p.4). Thus confusion has occurred in certain instances where one person has been talking about business model innovation and someone else is talking about a new type of vehicle therefore there can be vastly different opinions when discussing the organisation's problems (Claire i2, p.4). From an organisation perspective, many of these engineers are in middle-management positions and are key figures in the day-to-day running of the firm, thus their reluctance to engage with the process has been detrimental to design's influence within the organisation as it has caused tensions with the management who are trying to implement these processes (Philip i2, p.1).

6.4.5b Lack of strategic planning

The market for the subsea products is very inconsistent, which means that once every few years a large order will come along and certain members of the company will feel that the organisation's performance is about to improve, however this is often followed by periods of less favourable market conditions causing fear amongst the company (Philip i2, p.1). The innovation process within the company has historically been reactive rather than proactive (Peter, p.3), which has contributed towards this culture. Towards the end of the project, the company was commissioned to work on a large project that would have a strong influence on financial performance in 2017, however

there is a perception that everyone is talking about this piece of work and neglecting thoughts about how to improve R&D so that opportunities in the future can be taken advantage of, particularly in areas outside of the existing core business model that has led to streaks of good and bad performance (Philip i2, p.1). Claire (i2, p.1) echoes this thinking, suggesting that there is a need to separate the thinking within the business surrounding current needs in the market whilst allowing space to explore and exploit future opportunities.

6.4.5c Communication

Constant communication between the project team and senior management has been identified as particularly valuable in changing the perceptions of design at the strategic level of the organisation. The work has resulted in buy in from the majority of directors within the firm, who now appreciate the process and understand that the use of design in this way is likely to create value for the organisation going forward (Philip i2, p.2). Engagement with the senior management was also seen as critical in changing the preconceptions that particular directors had about design going into the project (Claire i2, p.6).

Conversely, the team has struggled to communicate the value of design to the wider organisation that will be affected by the work. Whilst the senior management team are now aware of what strategic design is, the rest of the organisation have lots of different opinions as to what the role of design should be and where the value is in adding design to operational processes (Claire i2, p.6). This has caused difficulties in having the work percolate down from the senior management and creating tangible teams, actions and programmes that respond to the stimulus created by the work (Claire i2, p. 5), leading to two different tiers of thinking within the business.

6.4.6 Summary of activity in Organisation C

The data for this case study was collected through a total of six semi-structured interviews with four different people, both before and during the integration of design practices into the organisation's innovation process. The case provides the perspective of the people tasked with using design processes in order to help the organisation understand potential market areas that they can exploit as technology changes the future scope for the organisation. The case discusses the way in which design has developed from a single project focusing on one of the organisation's existing products to a strategic resource that is key to the future growth of the organisation in a difficult marketplace that is subject to change depending on technology development and fluctuating oil prices. The findings explore the change in perspective surrounding design at the strategic level, in which design has managed to demonstrate business

value to senior figures from the organisation, however design is also struggling to influence decision making at the operational, middle-management level of the organisation. The cultural issues section outlines the resistance of engineers at the middle management level as a key issue in building the strategic influence of design, whilst outlining how frequent communication has helped to develop understanding amongst senior figures of the organisation.

6.5 Summary of case study design activity

This chapter of the thesis has presented the data derived from the research using a narrative structure in order to inform the reader of the key pieces of information that were established following the data collection process. The key points that were established within each case were influential in the analysis of the data that will be discussed in detail in the next section.

Organisations A and C implemented design in a similar approach, through the gradual introduction of the discipline over time, which began by hiring an industrial designer and engaging a University in order to facilitate the process. Organisation B differed in that it already had a design capability present within the organisation, however there was intent to grow the influence that design had on the innovation processes of the organisation, particularly in relation to strategic decision making that shapes the future direction of the organisation. Thus each of the firms had a desire to integrate design-led practices deeper into their existing innovation processes.

Over time, the influence of the design discipline increased in each case to varying extents. Organisation A was arguably the most successful in this process, where it managed to achieve recognition at both the strategic and operational levels, whilst overcoming a number of barriers along the way. Organisation B was successful to an extent, in that it managed to develop an understanding of the capabilities that the design team offer to the organisation, however it still faces difficulties in communicating these capabilities to other disciplines of the firm. In particular, it has struggled to build a relationship with marketing, who have historically had a large influence in the way that innovation is carried out within the organisation. Organisation C has achieved success in convincing the strategic decision makers of the organisation to support design in leading innovation activities that are capable of scoping future opportunities for the company. This has led to the adoption of design-led practices from the perspective of the leadership team, however the organisation has struggled to build on this momentum and gain support at the operational level. Middle management in particular have been reluctant to change their working practices and fail to see the market challenges facing the organisation in the same way as the leadership team.

Again, the aim of this research project was to understand the way in which DLI is implemented in science and technology-led organisations. The findings provided in Chapter 6.0 give an account of how this integration has occurred within three such firms, including providing an insight into the enablers and barriers to DLI that each organisation faced on their journey. The next chapter will discuss these findings in relation to existing literature within the field in order to generate relevant theory to answer the initial research question.

7.0 Discussion and interpretation of findings

This chapter aims to incorporate the findings from the research process outlined in Chapters 4.0, 5.0 and 6.0 into a broader discussion about the way in which DLI is implemented within science and technology based multinational organisations, in order to answer the focal research question.

The key contribution of the research is a demonstration of the relationship between types of design (design as an outcome, design as an approach and design as a capability) within science and technology-based multinational organisations that are in the process of implementing design-led approaches to innovation. It considers the way in which a change in one aspect of design's application can effect alternative areas of design within an organisation, which are typically viewed in isolation. This holistic approach has implications for the way in which the introduction of design is managed, offering insights into areas that should be prioritised by design managers, even if they are trying to elicit change in a different area of the organisation's innovation practices.

This chapter seeks to provide examples of instances where successful projects have led to the reduction of barriers to implementing DLI across organisations, as well as establishing connections that can be made across the implementation process. To achieve this, the chapter highlights links between types of design through specific examples derived from the case studies, before considering the relationship between these links and extant literature. The chapter begins with the introduction of a relevant model of organisational culture, which will act as an anchor between the findings and their position in relation to each other as well as wider organisation theory. The remainder of the chapter then follows a similar structure to the discussion in Gribbin *et al.* (2017), whereby each subsection will begin with a statement that aims to summarise a relevant segment from the findings, before discussing the occurrence of each statement as observed within the context of the case studies.

This will be followed by a discussion surrounding the relevance of literature to the specific findings within each subsection, in order to underpin the value of the findings in relation to the wider strand of research, as well as outlining any recommendations that can be made based on the strength of the findings.

7.1 A configuration model of organisational culture

The findings from the research demonstrate the way in which types of design are connected within the context of organisations, as well as outlining the effect that these relationships have on the integration of a design-led approach to innovation across each of the case studies. In order to facilitate the communication of these findings, it

was determined that it would be beneficial to either create or adopt a visual framework that is capable of demonstrating connections of this nature within an organisational context. To achieve this, a search was carried out across both strategic management and design management literature to identify the existence of any appropriate frameworks.

A search of strategic management literature uncovered a range of frameworks that are applicable to research into organisational contexts, however many of these frameworks have adopted an outward facing approach capable of documenting the external operating environments that companies are facing. Authors such as Porter (1992) and Ansoff (1957) describe the way in which organisations can gain competitive advantage through responding to market opportunities and threats with the creation of environmental models of competitive advantage. These models are seminal within strategic management research, however there are flaws associated with the underlying assumptions of each framework (Barney, 1991). Of primary concern to this study is the extent to which each framework fails to provide an adequate emphasis on the internal operating environment of the organisations in focus. This has also been the case within strategic management studies and has led to the creation of the resource-based view of the firm, which is primarily concerned with the internal strengths and weaknesses of an organisation above its external operating environment (*ibid.*).

The resource-based view begins with an appraisal of organisational competencies and resources in an attempt to understand those that are distinctive or superior in relation to rival organisations and as a result will become the basis for competitive advantage if correctly matched against environmental opportunities (Andrews, 1971; Peteraf, 1993). According to Daft (1983) firm resources include all assets, capabilities, organisational processes, firm attributes, information and knowledge that are controlled by a firm and enable that firm to conceive of and implement strategies that improve both efficiency and effectiveness. Instinctively, these types of resource are in alignment with the Philips framework that was used in the analysis of data, perhaps making the resource-based view suitable to frame the findings. On the other hand, there is a lack of existing frameworks that seek to document the relationships between firm resources and the way in which organisational change to certain resources can impact other resources within the firm. Much of the work in this area aims to quantify resources in relation to competitive advantage by determining the extent to which they provide economic value, are unique to the business, are difficult to copy and involve organisational support (Mathur *et al.*, 2007). Thus, the resource-based view seeks to pinpoint resources as enablers of competitive advantage, however it fails to chart the development of resources over time and the impact that resources have on the development of other aspects of the organisation.

Furthermore, there have been several attempts to identify models of the design process. This is typified by Dubberly (2005), who presents a comprehensive overview of over one hundred descriptions of the design process across several fields including architecture, industrial design and management studies. This collection includes the work of key authors such as Cross (1984), Archer (1964), Jones (1992), and Simon (1969), as well as many others in an attempt to encourage discussion surrounding design and its development process. On review of these models, it is clear that they are primarily focused on the application of design to a problem in a given scenario and consider the multiple ways in which the design process moves from identifying the initial problem to deriving the correct solution. Thus the focus is on design in isolation rather than the context in which it operates, particularly within the context of organisational functions.

More appropriately, within the domain of service design Junginger and Sangiorgi (2009) have developed a model capable of demonstrating levels of service design based on Levy's (1986) model of second-order change in which organisational worldviews range from core processes to an overarching paradigm. Within service design, this approach equates to service interactions at the core processes level developing to service transformation at the paradigm level. Sangiorgi (2011) further demonstrates that this framework is suitable to visualise change across organisations as well as social change amongst users and communities. Additionally, Warwick (2015) presents an adaptation of Young's (2008) framework, in which it is claimed that there are three levels to design impact: the service interaction level, the systems level and the community level. These levels depict the contexts in which design can operate and impact, and could be representative of a change in the way that design is used across each of the organisation cases over time.

A continued search of literature led to the identification of a configuration model of organisational culture presented by Dauber *et al*. (2012), who identify the presence of a dynamic relationship between organisational culture, strategy, structure and operations within any organisation and make the case for a configuration model of organisational culture to respond to research that aims to explore features within the complexity that organisations currently face. Figure 15 is the result of this work and highlights the relationship between internal features of an organisation and the way that they change through a process of performance assessment, single-loop learning, double-loop learning, guidance, operationalisation and patterns of behaviour. Furthermore the impact of the external environment is also considered within the framework, with the effects of wider environmental pressures also taken into consideration.

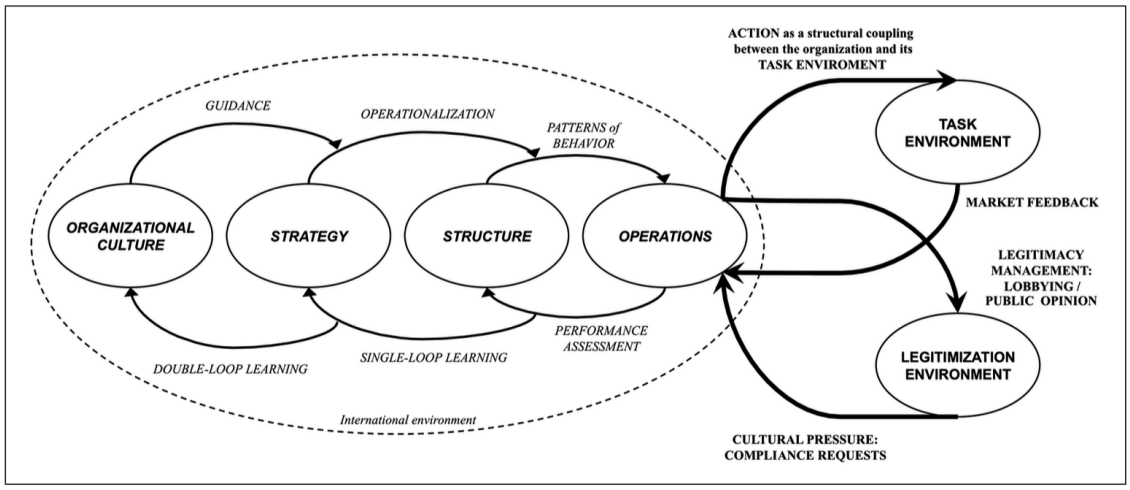


Figure 15: Configuration model of organisational culture - internal and external environment (Dauber *et al*., 2012).

As the findings of this study are primarily concerned with the development of design within the internal operating environment of the cases involved, Figure 16 documents the relationship between features of the internal environment suggested by Dauber *et al*. (2012). The selection of organisational culture, strategy, structure and operations date back to the work of Hatch and Cunliffe (2006), whilst Schein (1985) suggests relationships between three broader domains in a dynamic model of organisation culture: basic underlying assumptions, espoused values and artefacts. Dauber *et al*. (2012) successfully map the domains of organisational culture provided by Hatch and Cunliffe against the broader cultural domains provided by Schein in order to create the model outlined in Figure 16.

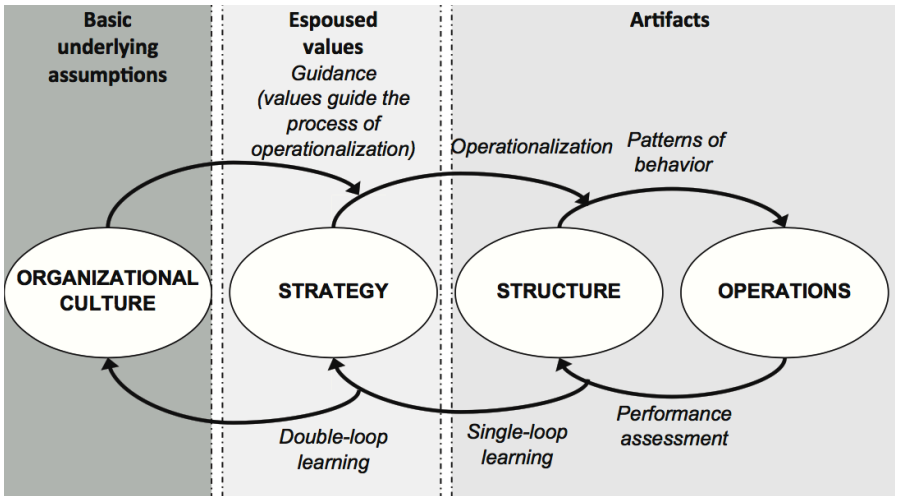


Figure 16: Configuration model of organisational culture - internal environment. (Dauber *et al*., 2012).

Figure 16 also demonstrates the way in which culture is both created and embedded within organisations. The creation of culture relates to the way in which reflection is carried out across all levels of the organisation, beginning with performance assessment at the operations level and then continued through the process of single and double-loop learning at the strategic level. Single and double-loop learning refers to the work of Argyris and Schön (1974), who highlight two different learning strategies derived from experience-based learning. The first of which is single-loop learning that involves the creation and adoption of new action strategies to understand inner values, which often takes the form of individuals attempting to improve the systems that they operate within. Conversely, double-loop learning occurs when people focus on the improvement of their inner values as opposed to merely understanding them. People begin to question the underlying assumptions behind their techniques, goals and values to understand why they do what they do. Within the context of organisations, double-loop learning refers to a more profound process of learning, whereby underlying policies and objectives are questioned and changed (Argyris, 1976). Similarly, Dauber *et al*. (2012) note that single-loop learning refers to the detection of errors and the adjustment of strategies to overcome mistakes, whereas double-loop learning questions existing assumptions and may lead to more fundamental changes in strategies.

The notion of single and double-loop learning is also an important concept within design practice. Wolff *et al.* (2016) highlights that double-loop learning is particularly critical in the process of organisations absorbing new capabilities, including design practice. Furthermore, according to Argyris (1976) double-loop learning is focused on improving the problem solving capabilities of people who are involved in solving complex and ill-structured problems, which are capable of evolving as problem solving advances. Thus double-loop learning is particularly desirable within the context of design-led organisations, where both thinkers and practitioners are typically expected to solve problems that operate within these boundaries (Gribbin *et al.*, 2016).

Once organisational culture has been established through this reflective process, it is then embedded throughout the organisation through the guiding values of the organisation. This process takes into account the way in which organisational strategies are turned into actions (Dauber *et al.*, 2012), and creates a feedback loop within an organisation. This feedback loop is important in understanding the connections that develop as design is integrated into the practice across each of the case studies. The following section will explain the key findings and their relationship to the model presented by Dauber *et al*. (2012) with the intention of demonstrating a greater understanding of how design is integrated across organisations.

7.2 Mapping the internal operating environment

Integral to the Dauber *et al.* (2012) framework of organisational internal environments is the presence of operations, structure, strategy and culture level factors that impact the development and diffusion of organisational culture. This section seeks to explore the findings of the research in relation to these individual factors.

7.2.1 Operations level factors

7.2.1a Design as an outcome

Design as an outcome is a critical first stage in building a successful culture for design. In organisations where there is little to no understanding of the potential that design has to create business value, successful initial projects that are intelligently communicated throughout the organisation have the potential to reduce several capability barriers in this area. This is particularly important as analysis showed a cluster of barriers that surrounded the process of establishing a mature culture for design during the inception of DLI across each of the cases (Appendix G). Likewise, in cases where design as an outcome is not sufficiently adopted at the beginning of integration, barriers to developing a mature culture for design remained in place for a longer period of time.

Design was integrated incrementally within Organisation A, with the first phase of integration focusing on the product aesthetics and brand identity of an existing product range to harmonise brand equity (Sarah, p.2). The success of this initial work led to the commissioning of further design projects, first involving the aesthetics of a wider suite of products before the company began to use design to solve more complex problems surrounding product creation (Isaac, p.3). Ultimately, the influence of design grew over consecutive successful projects to the point where a customer-centric approach to innovation was embedded at the core of new innovation projects within the division, whereby design was directly involved at the front-end of all new projects. At the forefront of this transition is a shift in employee perceptions from thinking of design as merely a tool to improve aesthetics (Paul, p.3) to thinking of design as a necessity for successful innovation. This transition mirrors the findings of Kolko (2015), who notes that design has historically been equated with aesthetics and craft, however design-centric culture has now transcended design as a role to impart principles to people responsible for bringing ideas to life and concentrating on the emotional experiences of customers. In this instance, successful projects that focused on the aesthetics of company products acted as the catalyst for further work to be carried out using industrial design at the front-end of new innovation projects across the division (Sarah, p.2). This approach also aligns with the experience of Brazier (2004, p.63) who finds that ‘a company’s first experience of design through a graphics project, if it is effective, opens its mind to considering design projects that require greater investment and longer-term projects’.

Similarly, within Organisation B, design to differentiate also played an important role in the implementation of DLI. In this instance, design was frequently used as a tool to ensure coherency across multiple brands as well as contributing towards the definition of brand strategy and identity (Chris, p.1). In comparison to the other cases, Organisation B is particularly focused on the performance of individual brands, with the capacity of design spread out across multiple brand teams (Penny, p.1&2). As a result, the role of design is centred around the performance of each brand and the organisation relies on design as a tool to differentiate in this space based on driving strategy and identity.

In Organisation C, the implementation of design in a top down manner meant that designers had permission to use design to innovate and optimise from the beginning of its introduction to the organisation (Claire i2, p.6). Because design then had the permission to act strategically during the initial stages, it neglected to engage with design to differentiate beyond an initial pilot project that aimed to create a new control cabin for one of the organisation's existing products (Claire i2, p.7). This permission was beneficial in that it embedded design at the front end of innovation almost immediately, providing the space to scope out opportunities to redefine their existing markets and also look at utilising their existing technology in a variety of ways that would eventually lead to the exploitation of entirely new markets to the organisation (Philip i2, p.1). Using design in this way was an expected outcome of the collaboration, however it was more difficult for design to innovate to produce 'quick wins' in the same way that design to differentiate has in the other cases. Consequently, it is extending the length of time that is needed to gain the trust of other disciplines within the organisation. In particular, middle management and engineers remained sceptical of the work throughout the duration of the collaboration (Philip i2, p.5).

It is clear that to grow the influence of design within an organisation, successes need to occur and be effectively communicated throughout an organisation to reduce capability barriers that occur during the initial stages of implementing DLI. Organisations A and B utilised design to differentiate to improve existing brands in a short time frame to achieve smaller successes, which allowed the influence of design to expand to more strategic projects. This aligns with the work of Borja de Mozota (2003), who notes that there are three ways in which design competence can be disseminated throughout organisations. One of which is the joint management of brand visualisation between marketing, communications and design. This process orchestrates the relationship between design and brand strategy to manage a global brand image and plays a key role in integrating design know-how into business procedures (ibid.). Within Organisation A this resulted in design being embedded at the front-end of the organisation's innovation procedures, having access to customers and the capacity to

identify potential market spaces that the organisation could seek to exploit. Beardsley (1994) notes that this front-end inclusion is particularly important in ensuring coordination of multiple product aspects in the area of technology, where design can act as the ideal bridge-builder between technology and its real users. Similarly, within Organisation B, this led to design having an impact on the strategy of multiple brands by identifying opportunities and new market spaces for the brand going forward.

In the case of Organisation C the permission to act in this way was already in place during the early stages of design's introduction, which had implications for the way in which design was utilised by the organisation and also the perceptions of design from other disciplines. Organisation C faced capability barriers on account of other disciplines not fully understanding the business value that design was in a position to add to the company, which was compounded by a lack of short-term projects leading to demonstrable successes (Claire i2, p.7). On the other hand, it has also allowed design to engage with strategic projects almost immediately, with the design team being afforded the opportunity to identify future opportunity spaces for the organisation using both existing technologies and new technology that could be developed. The benefits of identifying and exploiting these opportunity spaces are longer-term benefits to the organisation and have not been effective in providing demonstrable success and reducing scepticism amongst negative thinkers within the organisation. This has implications for future organisations attempting to integrate DLI into their organisational practices, as they should seek to use design to differentiate during the initial stages in order to reduce capability barriers through short-term successes, before pushing to integrate design as a strategic tool for mapping out the future direction of brands or a strategic roadmap for the future of an organisation. Acklin (2013) notes that creating prototypes has the potential to act as a tool to build this level of trust at the operational level. By acting as a collaborative tool providing insight into the design process as well as offering an opportunity to exchange knowledge and integrate views from non-designers into the work, prototyping provides a foundation of shared ownership across multiple disciplines (ibid.). Subsequently, achieving visibility of design outputs is a specific goal for design from day-one of integration and is an activity that can be planned for by management.

7.2.2 Structure level factors

7.2.2a The structure of the organisation

To varying extents, the macro level structure of an organisation is also an important factor in the way in which design is introduced to organisations. Organisations that successfully adapt their structures to coincide with the integration of design tend to reduce barriers to integration as well as facilitating the creation of strategy for design.

Within Organisation A, the initial structure of the particular division meant that sales managers were the primary point of contact between the company and its customers. These managers were located out in the field and had their performance measured in metrics that were particularly self-serving (Sarah, p.13). In particular, sizeable bonus schemes were in place based on individual sales volumes. This arrangement created a situation whereby the sales manages were particularly protective of their relationships with their clients and were reluctant to share contact details with other members of the company (Sarah, p.13). This directly conflicted with the introduction of design practices into the organisation and in particular proved to be a major barrier in establishing design at the front end of innovation; for example, there were instances in which the designer was not allowed to reach out to a customer with new ideas for a project (Isaac, p. 8&9). Additionally, the sales managers would be reticent to discuss knowledge about the customers that they were responsible for out of fear that others would step in and take control over accounts (Sarah, p.13).

Approximately a year into the collaboration, a management review led to the restructure of the particular division which moved many of the sales managers into different roles, leaving the marketing department to take responsibility for the client relationships (Sarah, p.13). This restructure streamlined the process for the designer to communicate with clients, as the marketing team were not incentivised based on their relationships with clients. Furthermore, by this point in the integration of design, the marketing team were heavily involved with the work being carried out by the designer and proved to be strong advocates for the discipline to others within the organisation (Sarah, p.16). Arguably without this restructure removing sales managers and providing design with direct access to the customers, design would have struggled to have the same impact on the organisation. In particular, it would have been detrimental to the success of developing new propositions based around a customer-centric approach to innovation.

On a larger scale, the structure of Organisation A determines that the performance of each division is measured individually in relation to the wider business. This leads to competitiveness between nearby divisions, which can stifle collaboration on new projects because there is a constant concern surrounding who will see the greatest profits out of any collaborations and fears that time and resources could be better spent working on self-serving projects (Sarah, p.5). Despite this concern, there have been attempts to introduce design to other European divisions in the form of small collaborative projects being carried out, driven by positive feedback from the Vice President of Innovation (Emma, p.4). This competitive culture is still prevalent however and inhibits the progress of design as a discipline as it discourages multidisciplinary

collaboration across the wider organisation as well as inhibiting design's potential to gain influence in decision making.

This type of compartmentalism is also seen in Organisation B, however the structure of the organisation means that the company is categorised by specific brands as opposed to geographic divisions. Again, there is a sense of internal competitiveness between the brands, however there appeared to be a greater level of cross-brand collaboration in comparison to Organisation A. Each of the brands within Organisation B is allocated a packaging director, who is in charge of resourcing and allocating design across the particular brand (Chris, p.1). As a result, the influence of design across the organisation is limited by the extent to which specific brand directors value design as an organisational function. In instances where particular brand directors fail to see design as a valuable resource to the organisation, they choose to allocate assets to other disciplines within the company (Chris, p.5). This becomes a limiting factor for design's capability to grow both capacity and influence over time as it is restricted by the views of particular individuals and not supported by the overarching strategy of the company.

Additionally within Organisation B, there is a policy of job rotation that dramatically affects design's ability to gain strategic influence. Typically people within the company are expected to change roles every three years, with the exception of those in marketing who are expected to move every eighteen months (Chris, p.3). At the brand level, marketing personnel are typically in the position of brand managers and are therefore in the position to commission design projects. Oftentimes, brand managers need to be convinced about the merits of a design project before committing to them and by the time a project is underway it is entirely possible that they are then moved to a different position within the company. Subsequently they are not in a position to see the progress that design makes on the particular project that they have commissioned and furthermore, design is again in the position where it needs to convince the replacement manager about the benefits of design to continue the same project (Chris, p.3). Thus in this instance, the structure of the organisation makes it difficult to build up trust through design projects, which impacts design's ability to grow in both capacity and influence. In particular, the movement of people makes it difficult to carry out performance assessments and create single-loop learning to embed design into the strategy of the company and reflect on the successes of design as an approach.

Organisation B also carried out an organisational restructure a short time prior to the commencement of this study, in a similar manner to Organisation A. This restructure was beneficial to the integration of design at the strategic level in that it reconfigured the structure of brands within the organisation, which coincided with the restructure of the management team, reducing the number of Senior Vice Presidents (SVPs) from twelve to four (Chris, p.2). Previously, each of the twelve SVPs had a corresponding

design team, which meant that design resource was spread thin across the organisation. Following this restructure, there was an opportunity to combine the organisation's design resource, which brought about new opportunities for design. One of the primary opportunities was the creation of a design capabilities team that were specifically tasked with creating a strategic vision for design that would be capable of outlining what the discipline could be across the larger scope of the organisation (Chris, p.1). This piece of work proved important in outlining why design should exist across the organisation as well as outlining the role that design could play at a strategic level going forward. As a result, the work then led to the development of maturity of *design as an approach* within the organisation, particularly in relation to design strategy. Arguably, this work would not have been carried out without the restructuring of the organisation and the integration of brands under the direction of four SVPs, highlighting that once again organisational restructure has acted as a catalyst in developing the maturity of design practice within an organisation.

In the cases of Organisation A and Organisation B, the management restructures were not carried out with the intentions of improving the position of design within the organisation. In both instances restructure was the result of a company deciding that changes needed to be made to streamline the strategic position of the company in an effort to sustain competitive advantage. Despite this, both of the restructures succeeded in removing some of the primary barriers that were impeding design's strategic growth across the companies. Specifically, within Organisation A, restructure provided the company with the opportunity to connect design with the customer base, which later proved critical in establishing a customer-centric approach to innovation; whilst restructure within Organisation B allowed the unification of the organisation's design resource as well as providing the discipline with an opportunity to outline its strategic vision for the future of design as an organisational function.

Unintended consequences of organisational restructure have therefore allowed the influence of design to grow in each case. Senge (1990) notes that the structure of an organisation is key in generating behaviour throughout the organisation, therefore it is perhaps unsurprising that the structure of an organisation has demonstrated the potential to inhibit or encourage the absorption of DLI. Authors such as Buchanan (1992) and Hugentobler (2017) have suggested that organisational structure is a complex domain, however this broadens the possibilities for design to contribute to transformation through deriving alternative organisation ideas.

In order to achieve this type of purposeful restructure, Heskett (2005) identifies that the emphasis on design must be placed on constructing systematic approaches to the overall output of a company, in particular at the corporate-wide strategy level. According to Kanno and Shibata (2013, p.17), these discussions should revolve around

the decentralisation of design divisions with the intent of providing design divisions greater authority, creating an environment to mitigate the impact of engineering and other divisions and making it easier for design divisions to lead the execution of corporate design strategy. Whilst these factors are regarded as important in organisational transformation, Kanno and Shibata (*ibid.*) also stress the importance of corporate-wide design management that keeps these factors in mind throughout transformation. The findings therefore indicate that there is potential for design managers to improve the prospects of design within an organisation by utilising organisational restructures to purposefully reduce barriers to DLI; however they echo the work of previous research in suggesting that this approach would need support at the executive level to be successful.

7.2.2b Creating a suitable space for innovation

The creation of a suitable space for innovation appears to be of importance in organisations integrating design for the first time and played a particularly crucial role in Organisations A and C, where there was no prior design capacity upon beginning efforts to establish a design function.

Within Organisation A, the success of two initial projects led to the creation of a workspace with the primary intention of creating a place that could facilitate meetings focusing on innovation. The original layout of the office space was designed in such a way that to hold a meeting in a dedicated space, a room had to be booked at the opposite side of the building. In order to reach the room, staff had to travel across the manufacturing floor, which meant taking the time to put on and remove relevant safety equipment just to reach the space (Sarah, p.6). Furthermore, the room was described as stuffy and unpleasant (Mark, p.4) which, when combined with the general inconvenience in reaching the room, further reduced the motivation of employees to seek out the space. In an effort to correct this, the marketing manager successfully obtained funding from the executive level of the organisation to create an innovation space that could provide a dedicated area for collaborative working that could be utilised by the members of marketing, engineering and design teams when working on new and existing projects (Mark, p.4).

The completed innovation space was termed a ‘Trojan horse’ by the marketing manager as it provided a space that encouraged collaboration between the necessary innovation functions, without management explicitly telling people to conduct work in this manner (Mark, p.4). The space itself was located in between the marketing and engineering departments and was equipped with a whiteboard, computers, space for people to meet as well as being home to an innovation toolkit that contained guides to brainstorming. The use of the room was largely flexible in that it couldn’t be booked;

instead people were able to put a post-it note on the door to indicate that they wanted to use the space and as a result people felt like they could enter whenever they needed to (Isaac, p.2). Ultimately, positive feedback surrounded the creation of the space and this led to the refurbishment and rebranding of the entire office space with the specific aim of encouraging collaboration across wider departments within the division. This also resulted in the senior management deciding to roll out the changes across the entire European branch of the business, a decision that advocated the work that design was carrying out within the UK division, whilst underpinning its importance to the innovation processes of the company (Sarah, p.7).

In contrast, Organisation C utilised a physical working environment to integrate design into its innovation processes by establishing a design function in a different building to their core enterprise. There was recognition from the management team that the organisation in its current state was failing, in that it was struggling to innovate and generate new products that are capable of providing the sales necessary to ensure the firm's survival (Philip i1, p.1). It was believed that the negative thinkers within the organisation's current engineering dominated processes would suffocate the efforts to establish design as a new way of thinking within the company; primarily because middle managers within the engineering function were used to working in a specific way and had no interest in embracing change, as well as creating a vocal opposition to actively derail new ways of working (Claire i2, p.6).

Subsequently, the organisation took up space in a new office building, with the intention of providing an area in which the design function could be established. The new office was situated in close proximity to both Northumbria University and the design strategy consultants employed by the organisation. Furthermore, the principal engineer was assigned to the workspace and tasked with carrying out the delivery of a new project focusing on identifying opportunity spaces surrounding autonomous subsea vehicles (Philip i1, p.1). Additionally, all future design work was to be carried out in the new office space, external to the perceived negative thinkers at the middle management level of the organisation. The use of this workspace ultimately provided the design team with the space to adopt a strategy of failing little and often out of sight from negative managers who would deem that any failures justify the existing processes of the company above any changes that supported the role of design (Philip i2, p.5).

The role of office space is important in the development of design across both organisations, however in each case the purpose of the space plays a different role in relation to establishing the discipline. In Organisation A, the office space acted as a connecting feature that fostered collaboration generally across the division's innovation function. In particular, the space became a physical manifestation of the customer-centric innovation process that the company strived to adopt (Sarah, p.7), embedding

the notion that design was central to the front-end of innovation projects and distancing the innovation processes of the organisation away from previous connotations surrounding the seclusion of people, focusing on their individual roles and ideas. This provides an example of the work carried out by Moultrie *et al*. (2007) who note that innovation spaces can provide a physical embodiment of an organisation's desired modes of working, in particular in relation to reflecting an organisation's strategic intentions. Similarly, the work space acted as a catalyst to collaboration between the design, engineering and marketing departments by providing an area in which the departments could meet with access to materials necessary to carry out creative brainstorming and evaluate ideas. In this sense, the work space acted as a facilitator of multidisciplinary collaboration, which Seidel and Fixson (2013) indicate is necessary for modern design-thinking.

Conversely, in Organisation C, the space acted as a safety measure to allow design to establish itself away from negative disciplines that were influential within the organisation, when it was believed that these disciplines had the potential to limit the scope for design's growth across the company. Culturally, this is in contrast to the approach of organisations such as Pixar in which designers are often encouraged to fail quickly and often to move on to the best solutions as soon as possible, creating the ideal outcome in the long run (Lockwood, 2009). Instead, failure was seen as something that would justify the beliefs of the engineering department who felt that there was no need for change within the innovation processes of the company on the basis that there are products currently in production that were designed ten years ago and still bringing sales into the company (Philip i2, p3). This situation exhibits symptoms of an organisational ecosystem that is antagonistic to design, demonstrating one of nine cultural mindsets that Jenkins (2009, p.25) finds are 'endemic within organisations and enemies of design'. Specifically, according to Jenkins (ibid.) a culture focusing on performance and short-term success is the antithesis of an environment in which learning from failure and looking towards long-term outcomes is the norm. In this instance, by seeking to externalise the design process from the company's existing innovation processes, Organisation C was seeking to utilise a new working environment as a means to distance itself from the existing culture of the firm and develop a new set of principles that is supportive of design within the innovation process.

7.2.3 Strategic level factors

7.2.3a Integrating design into organisational processes

The integration of design practice into existing organisational processes is critical in developing maturity of design as approach, particularly in relation to design delivery. In

Organisation A, an extensive piece of work was carried out in which the aim was to identify precisely where design should fit into the organisation's existing innovation processes. This piece of work acted as a negotiation between the design, marketing and engineering functions and included project managers and senior management (Sarah, p.3). The process proved to be critical in embedding design at the front end of innovation within all future projects that are carried out by the organisation, as one of the key findings from the initial design projects was that design could have a greater impact on final concepts when it was brought into the initial stages of projects in comparison to projects where design was tasked with making visual improvements towards the end of a project (Isaac, p.7). Formally recognising that design should be utilised at the front-end of innovation projects reduced the occurrence of design being asked to problem solve towards the end of projects at a time where the majority of work has already been completed and the impact that design is able to have is minimal (Paul, p.11).

In Organisation B, before the creation of a design capabilities team, many design processes were carried out external to the company, with aspects such as simulation, prototyping and CAD all being outsourced (Chris, p.6). This reinforced the role of design as a discipline that has no ownership of the briefing process making it difficult to increase the maturity of practice in relation to growing design as an approach. Internalising these aspects gave the design function control over the briefing process and changed the way in which design interacted with other disciplines within the organisation, transitioning from an external resource to a resource that was better positioned in the decision making process of the company's innovation practices. This ultimately led to the creation of a holistic brand design programme focused on brand centric design that changed the way in which other functions viewed design for experiences within the company (Chris, p.6), mirroring the transition made by Philips Design as discussed by Gardien and Gilsing (2013). This made people from the technical insights team nervous as it was a differing approach to understanding customers, however it gained traction within the wider marketing teams which has helped to increase the reputation of design as a tool for understanding customers and creating brand experiences (Penny, p.6).

Upon completion of the research, DLI was not formally integrated into the processes of Organisation C. Therefore, by comparing this case with the other two, it is possible to infer some best practices from the other two cases to offer some insights into better ways to carry out this integration. Within Organisation A, the integration of design into the existing innovation processes acted as a formal negotiation between design and other key disciplines across the innovation capability of the firm. This was highly beneficial as the negotiation provided a platform for the design function to persuade other disciplines of the value of design practices at the front-end of innovation on all

new projects, in comparison to making minor aesthetic changes towards the end of existing projects. Similar negotiation within Organisation C would be beneficial in that it would formalise the design within the innovation process, whilst providing an opportunity to discuss the mechanics of DLI with currently sceptical disciplines, in particular engineering. On the other hand, the strength of design's negotiating position in this process was supported by several successful interventions on innovation projects using design to differentiate. This would be lacking within Organisation C as they have chosen to focus on using design to innovate, which will take a longer period of time to demonstrate successes. Therefore it would be beneficial for Organisation C to only initiate this process when they have multiple examples of successes that can be utilised to convey the impact that design can have on business value to other disciplines within the organisation.

Additionally, internalising all design practices also appears to be beneficial to integrating DLI, as seen in Organisation B. Bringing design practices in-house strengthens the internal skillset of the organisation and improves the maturity of design as capability across the firm. In particular it improves the ability to leverage design across projects and create benchmarks for the discipline, whilst also acknowledging any knowledge gaps that are present across the function providing an opportunity to further strengthen the discipline going forward (Gardien and Gilsing, 2013). Since much of the design capacity within Organisation C is derived from external consultants, it would be worthwhile for the management to conduct a review of the activities carried out by these people and make efforts to internalise this resource into the creation of a bigger design function. This would also strengthen the position of the discipline in relation to the other innovation functions, which could be particularly useful in resolving conflicts with the engineering department.

7.2.4 Cultural level factors

7.2.4a The role of a design champion

All three cases underpin the importance of having a design champion within the organisation when attempting to introduce design practices. Holland and Lam (2014) define a design champion as someone who is responsible for the promotion of strategic thinking behind design activities. Typically, the role of a design champion is seen as important in overcoming challenges at the strategic level (ibid.), however in each of the cases the role also had implications for the way in which design was integrated at an operational level.

At the operational level of Organisation A, Mark, the division marketing manager acted as the primary champion of design. Mark was responsible for the initial introduction of

industrial design into the company, following a conversation with a University representative at a business event, whereby Mark outlined the challenges that the company were facing in their attempts to grow the business (Sarah, p.1). This conversation led to the initial branding and aesthetics project that initiated the introduction of DLI into the company's innovation practices. Over time, Mark acted as an advocate of the discipline, directly championing the work that was being carried out to the senior level within the business, as well as communicating the process at the operational level of the business (Mark, p.10).

The division marketing manager was also responsible for the selection and recruitment of an engineering manager and utilised this opportunity to appoint someone who was also sympathetic towards industrial design. This also had a significant impact on the way in which design was communicated throughout the company. The engineering manager was critical in explaining the new role of design to the existing engineering department, where there were initial reservations surrounding the introduction of design (Paul, p.10). These reservations included fears that design would eventually take jobs away from the engineering department, whilst taking away tasks that engineers found satisfying to work on in the shorter term (Emma, p.2). The engineering manager explained to the team that the presence of design was about specialising within the organisation's innovation processes and that the growth of the company meant that it was necessary to specialise in this way to remain competitive. As such, engineers were told that their jobs would not be under threat by design and that they would still be able to take part in many of the aspects of projects that they enjoyed to work on (Emma, p2&3). Moreover, the success of design in Organisation A led to a long-term increase in staff within the organisation as they developed an internal 'growth department' (Mark, p.13), which consisted of the disciplines of marketing, engineering and design. This increase in staff has the potential to be useful in allaying fears of job losses in situations where staff are exhibiting similar concerns surrounding the introduction of design, by providing an example whereby the introduction of design has led to the strengthening of the innovation team rather than weakening its position by removing engineers.

The role of design champion was also important at the strategic level of Organisation A, where it was undertaken by the Vice President (VP) of Technology and Innovation, who was informed of the design work through the continued advocacy of the division marketing manager. The VP witnessed the results of the second project involving industrial design, in which it carried out a customer-centric piece of work focused on redefining the organisation's existing technology propositions to fit new market spaces (Sarah, p.7). The division marketing manager explained that initially it was difficult to persuade managers at a local level to release the funds needed to successfully grow the design initiative, particularly in relation to securing funding to create the 'innovation

lab' space. However, having seen the work carried out in this project, the VP was convinced that the introduction of design to the organisation's innovation practices was critical to the future competitive advantage of the organisation (Mark, p.5). Subsequently the VP contacted some of the local managers and explained that they should continue to grow the design initiative, which convinced the local managers that it was suitable place to add investment (Mark, p.5). Equally, the VP was able to champion design on a global level which attracted interest from other divisions within the organisation, leading to further collaborations and an increase in design's influence throughout the wider company (Emma, p.4).

In Organisation B the role of the design champion was fulfilled by a Vice President of Packaging within the organisation. The VP had prior experience as a packaging designer within the organisation and utilised the role of VP to champion the use of design at the strategic level (Chris, p.2). This led to both the hiring of a new Design Director and the creation of a design capabilities team who were given the responsibility of carrying out an audit of design practices within the organisation to understand how design is practiced across the company and whether design could add additional value in relation to its brand propositions (Chris, p.2). Initially, this strand of work proved to be unsuccessful after a year and a half of frustrations from senior executives, who felt that the director was unable to influence, convince or demonstrate what design was going to do (Chris, p.2). At this point, there was a change in personnel orchestrated by the VP in which a new Design Director was hired, however on this occasion the director was provided with a bigger scope to carry out the necessary work. Specifically, they were tasked with looking at why designers should be present across the entire organisation as well as identifying the role that they could play in adding strategic business value (Chris, p.2). The position of a design champion at the VP level was critical in ensuring that the Design Director and capabilities team were given an appropriate amount of time and space to work on their propositions without judgement from other areas of the company. This was particularly important given the dominance of marketing within the firm, however it was also important in deflecting pressure from the senior management of the organisation who were sceptical of the role of design at that point in time.

The role of design champion within Organisation C was taken up by the Chief Technology Officer (CTO) who was responsible for hiring the first industrial designer within the company, as well as commissioning consultancy and University projects to carry out a piece of work aiming to utilise strategic design in order to exploit new markets (Harry, p.1). In this role the CTO frequently had to champion design to the organisation's board of directors so that necessary funding could be acquired to carry out the work (Philip i2, p. 2&5). This was an important role as historically funding within the company was been allocated based on projects, where the funding was initiated

from clients (Philip, p.4). Subsequently, the support of the CTO was essential in order to convince the board of directors that integrating design and carrying out this work would have a positive effect on the firm's financial performance.

In each case, the role of design champion was critical in ensuring that design was afforded time and space to grow away from some of the existing dominant disciplines that are in place across each company, in particular engineering and marketing departments. Similarly, in each case the role of design champion was a critical factor in ensuring that the design teams had assistance in terms of acquiring necessary financial support to carry out new initiatives. In this sense, senior executives have remained engaged with the DLI process, which Govindarajan and Trimble (2010) suggest is necessary to mediate ongoing conflicts. This is particularly important during the initial stages of integration, in which design as an approach is being developed and an organisation is beginning to calculate the role that design can have within the context of its existing innovation programmes. Managers can then aim to introduce design into the organisation's existing strategies, or innovation 'performance engine' (ibid.), once successful design projects have taken place and other disciplines have a clearer understanding of the business value design can add. Hands (2009, p. 40) refers to this role as 'coalition developers', in which the champions seek to solidify the involvement of people who have access to resources, knowledge and political influence needed to enact change at this level.

Furthermore, the presence of a design champion at the strategic level is critical in building the influence of design on strategic decision making. This was particularly evident within Organisations B and C, whereby design was afforded the opportunity to set out vision for the future direction of the organisation through either new brand strategies or the identification of new spaces for technological innovation. Organisation C in particular draws parallels with the role of design within P&G as described by Martin (2009), in that the company was in a position where its sales were declining and strategic level management felt that change was needed to turn around the future prospects of the company. This strategic position ensured that people were more open to change having realised that it was critical to the future performance of the company (ibid.).

Much of the literature in this area focuses on the impact that a design champion can have at the strategic level of organisations, however Organisation A demonstrates that a design champion at the operational level of an organisation can also have a significant impact in reducing the barriers to implementing DLI. This is particularly important when design is introduced in a bottom-up manner, in which case it is valuable to have a supporter in a management position to consistently communicate the business value that design is adding to projects on a day-to-day basis. In the case of

Organisation A Mark acted in this role by repeatedly explaining the vision for design, demonstrating the impact that design had on active projects and then communicating customer feedback to senior management followed by linking these aspects to actual sales growth (Mark, p.5).

There is also a large focus within literature on the role that particular individuals have as design champions. It is also worth considering the impact that multiple champions can have within particular organisations, where the creation of a 'community of champions' is perhaps a more relevant explanation of the process. This is seen within Organisation A, where multiple people take on the role of champion at different stages of integration and at different levels of the organisation. Creating this type of community is critical to the long-term success of integrating DLI. Within a situation where there is only one design champion, an organisation is vulnerable to losing that influence should the person decide to change roles or leave the company. Similarly, in instances such as Organisation B, features surrounding job rotation mean that the position of design champion is difficult to establish at the operational level because there is a constant state of flux surrounding management roles. In these instances, the impact of a design champion on the integration of DLI would be far greater if the organisation managed to create and sustain a community of design champions that were spread across the organisation and able to communicate the vision of the discipline simultaneously.

A community of design champions could also encompass the effect that external design specialists had on the DLI integration process across each of the three cases. All three organisations looked to the help of the University in establishing DLI, with Organisations B and C simultaneously hiring external design consultants. These external actors were all positive forces in championing design within the organisation. It should be considered that due to the fact that someone in the organisation decided to commit the time and money to bringing in external help, external help is often given more credence as people try to justify the expenditure. Thus external design specialists can also play the role of influencer by championing the discipline.

Finally, it is worth revisiting a point from Section 2.5.1, in that research has also indicated the presence of a champion is not necessarily sufficient in guaranteeing innovation successes. Rubenstein *et al*. (1976) highlight that many projects are demonstrably unsuccessful despite the presence of a person in the role of a champion. Subsequently, although the role appears to be an important influence in successfully integrating design within the innovation processes of the three cases in focus within this study, other factors are also important in deriving sufficient conditions that can credibly explain success (Rothwell, 1992). This perhaps explains the difficulty to integrate DLI within Organisation C, whereby the design champion was in place at the

strategic level of the organisation, however there were still barriers present at the operational level of the company.

7.2.5 Summary of internal strategic level factors

This section has aimed to document the findings of the research in relation to the four key phases of organisational culture identified by Dauber *et al*. (2012): operations, structure, strategy and culture. The results of this process are visualised in Figure 17. The next section will explore the factors that connect the key phases of culture, in order to provide a detailed description of design integration.

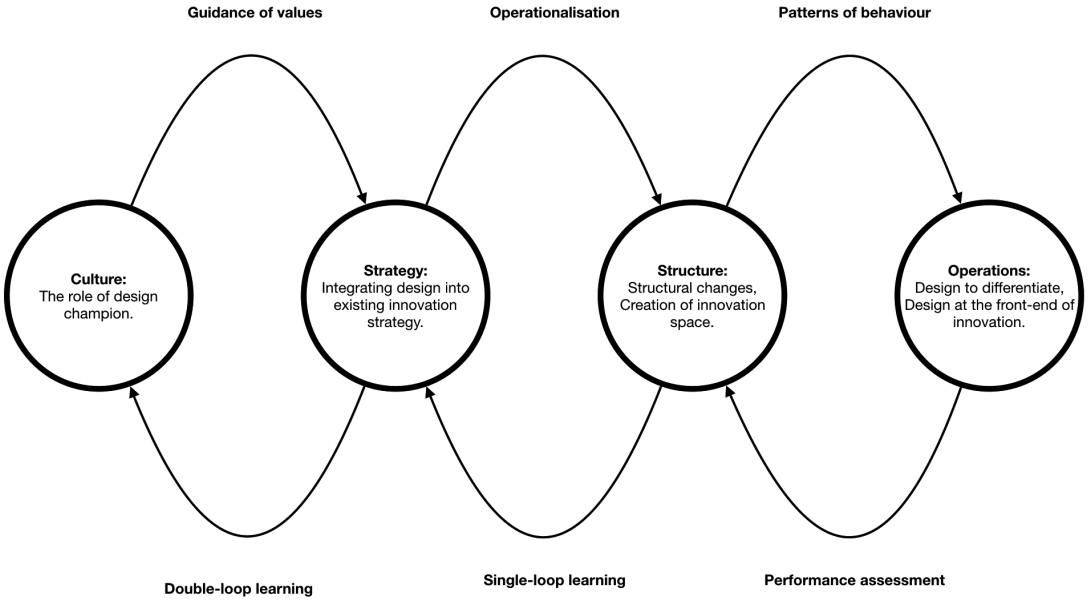


Figure 17: Findings in relation to the four key phases of organisational culture.

7.3 Exploring the connections between operational factors

Whilst the previous section documented the findings in relation to the four phases of embedding organisational culture, this section seeks to discuss the way in which these findings connect throughout the internal operating environment of an organisation. Some of these connections have been alluded to in the previous section, however this section will aim to make them explicit in relation to the role that they play with regards to implementing design.

7.3.1 Overcoming multidisciplinary conflicts through building trust

Many of the initial barriers across each of the three cases can be linked to the maturity of *design as a capability*, specifically with regards to resolving multidisciplinary conflicts surrounding the relationship between the design function and existing functions within the organisation. In particular, barriers such as a lack of understanding of the design process, contrasting attitudes and a fear of job losses are all connected to the creation of a mature *culture for design* within an organisation. It is necessary to overcome these barriers to establish a culture that encourages DLI across an organisation. This section will discuss the role of establishing trust and developing a successful communication strategy to overcome some of these barriers.

In instances where design is deemed to have a positive impact on business performance, trust begins to accumulate from other disciplines within the organisation. This is necessary for design to move from a position where it primarily impacts the operational factors of an organisation to embedding design within the structure and strategy of the company, leading to an impact on organisational culture. Within Organisation A, trust was built through the incremental use of design as outcome, as documented in Section 7.2.1. Small, successful projects led to the role of design expanding from its initial use as a creator of visual content, to design being firmly embedded at the front-end of new innovation projects (Isaac, p.3). Once initial interventions have taken place, performance assessment is typically carried out so that the organisations can evaluate the impact that design is having on the innovation process. In the case of Organisation A this evaluation process initially involved a member of the marketing team carrying out a piece of work to assess the customer perceptions of the new branding that was rolled out across the existing suite of products (Sarah, p.2). Holland and Lam (2014, p.51) classify this approach of assessing the success of design as ‘assessment by an internal individual’, in which a person can quickly assess issues highlighted in a design audit. Alternative methods of performance assessment can include assessment by: questionnaire, working group and external consultant (*ibid.*).

Similarly, within Organisation C, trust was built up through an initial project looking at the redesign of a control cabin for one of the company’s core products. The success of this project was enough to build trust at the strategic level of the organisation, with the Chief Technology Officer recognising the potential of design to add business value (Philip i2, p.3). In this instance, however, the work was treated negatively by other members of the organisation, in particular from members of the engineering team. The negativity from the engineering function was excessive to the point that the company established its design function in a location external to its primary offices in order to provide design with space to establish itself before being introduced into the existing innovation process of the company (Philip i2, p.5). This suggests that being successful

in small projects alone is not enough to establish design as a key function within the organisation's innovation processes.

Organisation B exhibited similar characteristics to Organisation C in its implementation of design in that there are examples of design having a successful impact on projects on particular brand areas, however the success of design was met with trepidation from other disciplines. Chris (p.5) highlights one instance in which the presence of a designer made the marketing team feel uncomfortable because the work that she was doing was so good, therefore the marketing team adopted the belief that design just gets in the way of the work that the other teams are trying to carry out. Upon the designer finishing their time in the packaging team, the role was discontinued and packaging engineers took up the role, further demonstrating that success in one project alone is not enough to establish trust in design if other disciplines are already inimical.

Section 2.5.4 documented the benefits of multidisciplinary working in relation to successful innovation, in particular due to multidisciplinary collaboration playing a central role in the application of design to innovation challenges (Seidel and Fixson, 2013). It is clear, therefore, that for design to succeed in the context of an organisation's innovation capacity it is essential for the removal of barriers to multidisciplinary collaboration, in order to facilitate collaboration between numerous disciplines. Furthermore, each of the cases exhibited signs of 'coopetition' (Luo *et al.*, 2006) in which there was a presence of both competition and collaboration. The findings from this research indicate that building trust of the design discipline is important in each of the cases, however it is also evident that trust must be built up over several successful projects and additionally, trust alone is not sufficient in embedding design practices through overcoming multidisciplinary conflicts.

One feature that is present within Organisation A and missing from Organisations B and C is that of a consistent communication strategy that stems from the people who occupy the design champion role within the company. Within Organisation A this resulted in frequent presentations to both senior managers and people at the operational level to ensure that everyone understood the design process and the impact that it was having on the organisation's innovation efforts (Emma, p.11; Mark, p. 10). This communication process was beneficial in two ways, both of which surrounding the ability of design to build understanding amongst other disciplines. It enabled the design function to communicate its capability to add business value on projects, whilst also allowing the function to communicate some of the processes that were used in projects, thus demystifying the concept of design to people who previously had no understanding of the processes involved.

Organisations B and C lacked a consistent communication strategy, which led to persistent barriers in comparison to Organisation A. In particular, a fear of design causing job losses was consistent in each of these cases whilst the organisations did little to reassure people that this fear was unfounded. In Organisation A this was solved through consistent messages from the management team that conveyed the message that design was an additional specialism that the company was investing in, in order to strengthen its existing innovation practices and maintain innovation as a competitive advantage (Emma, p.11). Similarly there was a consistent message that the involvement of design would not take away the responsibility of being creative from other disciplines, which was another concern that was particularly present amongst the design team.

Furthermore, Organisations B and C both have strong examples of design contributing to the innovation practices within each company, however they lack the communication strategy needed to convey the benefits to other disciplines throughout the organisation. This echoes findings from Carlgren *et al.* (2016), who highlight that one of the primary challenges in embedding design thinking into organisations is that it is difficult to prove the value that design thinking provides. In this research, however, the data collected offers a potential solution; by suggesting that in order to establish design within an organisation's innovation function, it is necessary to build up trust through successful projects whilst simultaneously placing importance on communicating the processes involved and the impact that the work has had in terms of adding business value to projects.

7.3.2 Top-down and bottom-up integration

The integration of design is also impacted by the way in which organisations go about introducing the discipline. This can occur in one of two ways, top-down implementation or bottom-up. Manzini (2014) notes that within social innovation, this polarity relates to who the original drivers of innovation are, with the top-down approach being driven by decision makers and the bottom up approach being driven by the communities directly involved in the innovation. Similarly, within a corporate organisational context, the top-down approach is driven by the decision makers of that organisation, typically in a management or senior-management capacity; whilst the bottom-up approach is driven by employee initiatives at the operations level of the company.

Within Organisation A, design was initially introduced to the company utilising a bottom-up approach that stemmed from discussions between the division marketing manager and Northumbria University. This discussion led to the initial aesthetics project that sought to improve the branding of the division's existing product offerings. As mentioned in Section 7.2.1, the success of the aesthetics and branding project led to

further projects at the division level, which resulted in the scope of design increasing over time. After several successful projects the work was noticed by the Vice President of Innovation, primarily down to the marketing manager acting as a champion for the work, pushing design at a corporate level ensuring that there was a global audience for the work that was being carried out (Mark, p.4). At this point a top-down implementation approach was also adopted across the whole organisation, stemming from the VP acting as a design champion for the work. Initially this involved freeing up funding so that the division could renovate the workspace so that it became suitable for the new collaborative innovation approach. Longer term, this also involved the VP rolling out the workspace changes to other divisions across the organisation, with the intent of spreading the culture that was developing within the North East England division into the wider, international organisation (Sarah, p.7).

The top-down approach was typified by Organisations B and C. Within Organisation B, much of the impetus for developing a design capability stemmed from the Vice President of Packaging who took advantage of an organisational restructure to create a team that would be responsible for identifying the role that design could play in shaping the strategy of the organisation (Chris, p.1). Benefits of this approach included creating space for design to develop a consistent set of methods that could be applied across any of the organisation's brands. In particular, focusing on design for experience as a way of turning insights derived from the marketing team into viable strategies for brand futures. Contrastingly, this approach was not able to overcome barriers in overcoming multidisciplinary conflicts. As noted in Section 6.3.4d there were examples of designers being placed into teams and carrying out successful work, however this was met with uncertainty from other disciplines and was not enough to establish design into the day to day operations of these brand teams. This success could have been improved upon by the presence of a design champion at the management level in order to reduce the multidisciplinary working barriers caused by a fear of job losses and design making the marketing discipline look bad to senior management.

Similarly, within Organisation C the stimulus for integrating design into the firm's innovation processes came from the Chief Technology Officer. Again benefits to this approach meant that design was given permission to think strategically almost immediately; in this case by identifying several potential areas that the company could either expand its technologies into or create new technologies to exploit emerging market trends. In this respect, the design function was given a high level of responsibility considering the company's existing situation in which it was struggling to compete within the changing conditions of the marketplace (Philip i1, p.1). Thus a top-down approach was particularly relevant for integrating design at the strategic level of the organisation. However, in a similar manner to Organisation B, design struggled to overcome barriers surrounding multidisciplinary conflicts. In this instance the

multidisciplinary conflicts stemmed from the operations level in which engineers and engineering managers were particularly sceptical of the work and reluctant to change, oblivious to the market pressures that were effecting the company (Philip, i2, p.1). A lack of bottom-up integration in this case meant that these barriers were not overcome within the timeframe of the study, however this can also be linked to the lack of using design to differentiate early in the integration in order to quickly demonstrate the business value of design.

The data suggests that in an ideal scenario there would be a degree of both top-down and bottom-up integration, which would be capable of overcoming barriers at both the strategic and operational levels of the organisation simultaneously. It is clear that both approaches offer particular benefits in overcoming barriers to implementing DLI, however there does not appear to be an optimal way of overcoming all barriers using only one of the two approaches. Birkinshaw *et al.* (2011) highlight that this is often the case with specific innovation projects, whereby both approaches are needed however very often the link is not made. Bottom-up integration appears to be essential for overcoming barriers at the operational level of the organisation, in particular in contributing towards overcoming multidisciplinary conflicts in instances where other disciplines are sceptical of design from the outset of its introduction. Additionally, a top-down approach makes it far easier to encourage the use of design in a strategic manner from the initial stages of introduction. As highlighted in Organisation A, the top-down approach is also beneficial in overcoming barriers surrounding finance and risk in situations where the company is committing resources towards implementing a new discipline. This is key in ensuring that design is rolled out on a wider scale than just one segment of a large organisation, particularly when design is initially implemented in a top-down manner beginning in one specific area of the company.

7.4 Mapping the integration of design-led innovation

Whilst the previous section set out to identify the operational factors that influence the integration of design into organisational innovation practices, this section aims to increase understanding by considering the way in which these factors are connected throughout the integration of DLI to create a theoretical model that best resembles the integration process. The results of this process have again been annotated onto the model provided by Dauber *et al*. (2012) and are shown in Figure 18. From a hierarchical perspective, culture refers to higher order, strategic level change within the organisation, whereas operations refers to activities that occur through the day to day running of a company.

Chapter 3.0 discussed the widely theorised notion that design within organisations exists on a spectrum between no formal design practice to design integrated in organisation strategy, however little clarity exists to offer insight into how organisations

move up this spectrum. In particular, there is little theory focusing on the barriers, enablers, successes and failures that are encountered on this journey; providing scope for research that is capable of highlighting areas for best practice to support this activity (Backes and Wolff, 2016). Primarily, this is because a range of strategies are implemented depending on the people leading this transition (Ward *et al.*, 2009) and also because it is difficult to directly correlate organisational change to a single specific intervention (Bucolo and Matthews, 2011a). Furthermore, existing research has provided models of the organisation that are presented as 'static' (Acklin, 2013) in that they do not consider changes over time that occur as a result of design interventions in an effort to integrate the discipline into innovation processes. As a result, they remain constant and unable to represent a social dynamic in a state of constant flux.

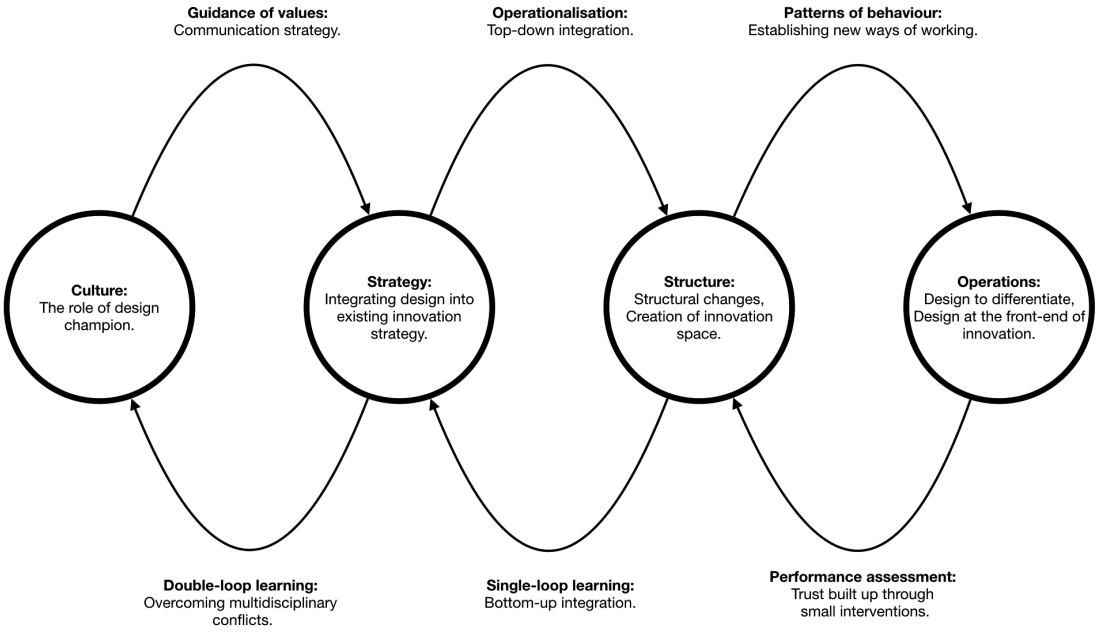


Figure 18: Findings in relation to the internal operating environment

This research has aimed to explicate some of the issues surrounding this integration amongst science and technology focused multinational organisations to improve clarity in this area. The three case studies have illustrated that integrating DLI into organisations is a complex situation that depends on multiple, context-specific, variables. Despite the individuality of the cases, clear themes have emerged from the analysis of data, leading to the creation of Figure 18 - a framework visualising the connections between the key findings from the study mapped against a configuration model that explains the connections between organisational culture and the wider internal operating environment.

The model depicts the relationship between the commonalities of integrating DLI and is cyclical to demonstrate that the integration of DLI is dynamic and issues aren't situated in specific timescales relative to design's introduction. In terms of a starting point, much of the integration depends on the initial context of integration, in particular whether an organisation is approaching it with a top-down or bottom-up strategy. The top-down approach suggests that developing a strategy for design across the organisation is at the forefront of integration, with key issues surrounding embedding design into the structure of the organisation as well as establishing successful projects at the operational level. Similarly, the bottom-up approach relies on the successful performance of design at the project level to establish trust in the discipline, increasing design's influence and integrating it into organisational structures. The data highlighted that a combination of top-down and bottom-up integration is the optimal approach for integrating design, therefore it is possible for multiple feedback loops to occur at the same time. This indicates that the occurrence of simultaneous feedback loops is a necessary precursor to integrating DLI and overcoming barriers in the shortest possible timescale.

Additionally, the cycles are continuous meaning that multiple iterations are likely over the course of integration. For instance, performance assessment will be carried out multiple times over several projects. Some of which will result in structural changes, creating new ways of working across a company. These new ways of working will again lead to further projects and subsequently further performance assessment, creating a continuous loop of improvement over time. As an example, within Organisation A the initial branding work was sufficient to encourage the marketing manager to seek investment to improve the immediate office space. The improvement of the office space then led to new ways of working that embedded DLI into the existing innovation process of the organisation, with design-toolkits being provided within the office space for use on future projects. This then had an impact on the use of design within future projects causing the cycle to repeat.

Ultimately embedding design into the culture of an organisation relies on overcoming barriers and capitalising on the enablers surrounding DLI. Subsequently these feedback loops become important in continuously improving the design function of an organisation over time. In particular, the feedback loops are important in improving understanding from other disciplines surrounding their awareness of design's ability to add business value; either at the project level or the strategic level. This was one of the most prominent barriers across each of the cases at various levels of the organisations. Despite this many of the enablers addressed this issue. The presence of a design champion was particularly important in this area, as in certain cases it was an essential precursor for design to have the necessary time, space and funding required to establish itself as an organisational function. Furthermore, successes and trust building

at the operational level had to be supplemented with a consistent communication strategy to ensure that positive results from projects were shared throughout organisations, providing sceptical disciplines with insight into both the processes and outcomes possible from design-driven innovation projects.

7.5 Relevance of theoretical framework to praxis

Whilst the framework appears to offer the best theoretical explanation for the way in which a design-led approach to innovation is integrated, it is worthwhile considering its suitability as an accurate model of design praxis. This section of the thesis considers the way in which design was integrated across each of the Organisations in relation to the initial framework, culminating in a discussion surrounding a potential idealised version of the framework to be utilised as part of future research.

The section also takes into account feedback from a follow up interview with a representative of each participating organisation: x from Organisation A, y from Organisation B and z from Organisation C. The follow up interview was carried out in order to validate the findings of the thesis and determine whether the models could provide an accurate description for the integration for design within each case.

7.5.1 Integration within Organisation A

The way in which design was integrated within Organisation A, appears to have connections between the operations level and strategy level that are not discussed as part of the framework of Dauber *et al*. (2012). To demonstrate the process of integration within Organisation A, Figure 19 documents the bottom-up approach followed in the early stages of design integration; highlighting the circular approach taken by the organisation following the initial branding project that occurred at the operations level.

Stage 1 represents the initial branding and aesthetics project that led to structural changes within the organisation, in the form of staffing changes within the operating structure surrounding the existing innovation process. In turn, this led to Stage 2, a removal of barriers surrounding design's ability to connect with the customers of the business. As a result, Stage 3 shows that design was then embedded at the front-end of innovation for ongoing and new projects. Critically, at this stage, embedding design at the front end of innovation at the operations level connected directly to the integration of design within the existing innovation strategy of the organisation. This occurred as the success of design at the front-end of innovation had a visibly positive impact on projects, which led to a process of negotiation between design and the other innovation functions to formalise the role of design into the innovation process of the

company. This cycle demonstrates that it is possible for linkages to exist that are not present on the initial model of Dauber *et al.* (2012).

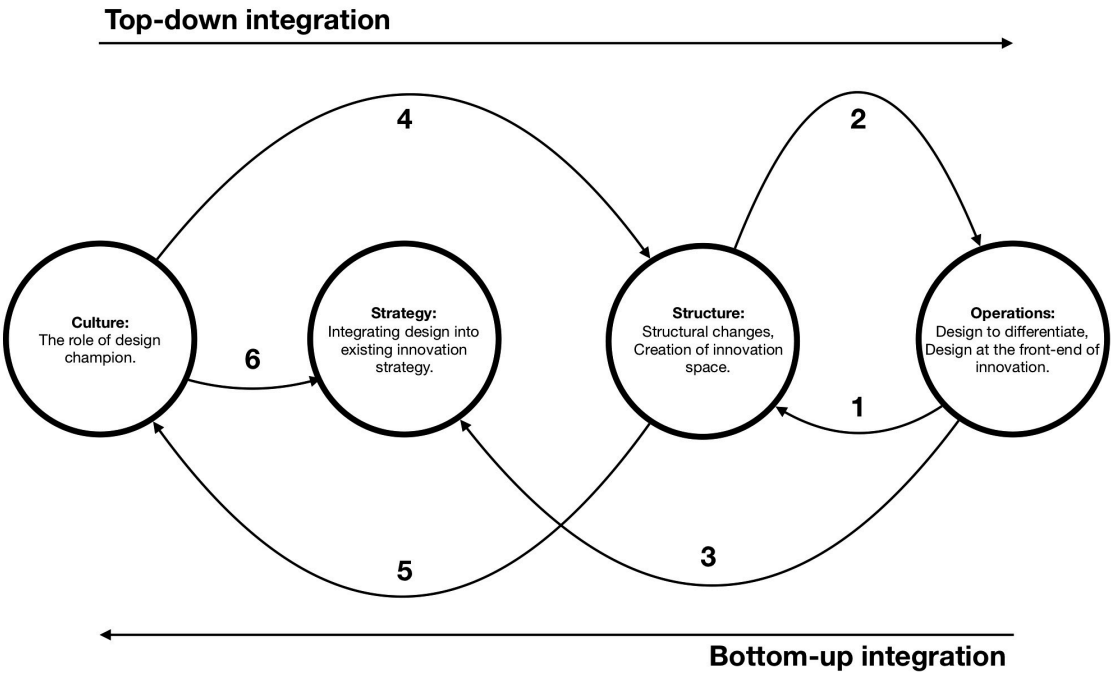


Figure 19: Integration within Organisation A.

The success of design projects at the operations level also led to recognition from senior management, in particular the Vice President of Innovation. Support from senior management was essential in gaining funds to redesign the office space within the UK division, in particular in creating an area was more suitable to facilitating team based innovation projects, highlighted in Stage 4.

Following the creation of the innovation space and further successful design projects, there was also a reduction in multidisciplinary conflicts that were caused through the integration of design. Engineers who previously had reservations surrounding the impact that design would have on their own role within the organisation began to better understand the processes involved in design-led innovation and in turn contributed to the successful outcomes of projects, embedding design further into the culture of the division as shown in Stage 5.

Critically, a deeper understanding of design-led innovation across the division led to a negotiation process where design was formalised within the company's existing innovation process, Stage 6. This involved layering the role of design onto an existing Stage-Gate process, to ensure that design was in position to be an active participant at the front-end of all future innovation projects that originated from the Division.

Specifically, this meant that the industrial designer was able to spend time with customers when new projects are initiated as well as having input into the ideation of product concepts, as well as impacting the final form of new products.

It was also possible to map the Stages developed in this model against the coding carried out in Figure 9. The results of this process are documented in Table 10. This process cross checked the critical incidents identified in Appendix F against the distinct stages identified in the creation of Figure 19 to demonstrate the way in which maturity changed over time. This process has also been carried out for Organisations B and C and is documented in Tables 11 and 12.

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Design Strategy	0	0	0	0	0	1
Design Programming	1	1	1	1	1	2
Design Delivery	1	2	2	2	2	2
Design to Innovate	1	2	2	2	3	3
Design to Differentiate	1	2	2	2	3	3
Design to Optimise	1	1	1	1	1	2
Design Skills	0	0	0	0	0	1
Competence Development	0	0	0	0	0	1
Culture for design	1	1	2	2	2	2

Table 10: Changes to maturity within Organisation A

7.5.2 Integration within Organisation B

Initially, the design resource within Organisation B was spread across twelve product categories, which meant that it was spread thin across the organisation. In 2013, organisational restructure occurred, which saw a transition from twelve to four major categories. As part of this transition, each of the four major categories was assigned their own design resource and a Design Director was appointed by the Vice President of Packaging with the view of overseeing each of the design teams across the four individual categories, as highlighted by Stage 1.

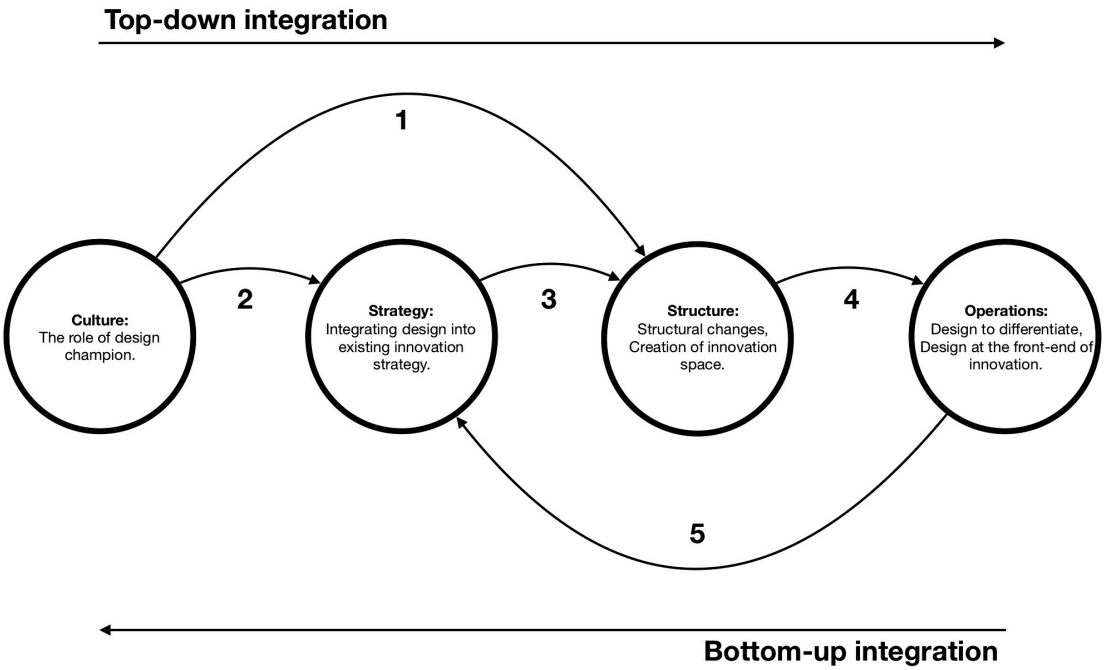


Figure 20: Integration within Organisation B

At this point, the Vice President of Packaging also requested the Design Director to carry out an evaluation of the organisation's existing design capability in order to determine why designers should be present across the organisation, what they should be delivering and also what value they could provide to the existing business strategy. This work led to recognition that design needed to take up several forms within the organisation in order to influence decisions within it, in particular design for experience, design for strategy, design for leadership and design for engineering were identified as key areas that design needed to deliver within the organisation. There was clarity surrounding the role of design for experiences, however the other areas were thought to be missing and the organisation set about looking at how design could deliver clarity within these areas across the organisation, represented by Stages 2 and 3.

Formally establishing the different roles of design within the organisation led to Stage 4, where multiple design projects were initiated at the operations level of the organisation. One of these design projects involved Northumbria University facilitating a workshop alongside an external design consultant in order to explore ways in which the packaging of a particular product could be reduced by 50%. These projects meant that design was able to contribute towards the overall strategy of the organisation, Stage 5, however despite successful occurrences of design-led innovation, multidisciplinary barriers were still present across the organisation. These barriers meant that design was able to influence the wider strategy of the organisation at this

stage, but unable to reach the point where it was able to inform culture change across the organisation.

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Design Strategy	0	0	2	2	2
Design Programming	0	1	2	2	2
Design Delivery	0	1	1	2	2
Design to Innovate	0	1	2	3	3
Design to Differentiate	1	3	3	3	3
Design to Optimise	0	1	2	2	2
Design Skills	2	2	2	3	3
Competence Development	0	0	1	2	2
Culture for design	1	1	1	2	2

Table 11: Changes to maturity within Organisation B

7.5.3 Integration within Organisation C

The initial introduction of design-led innovation to Organisation C occurred in the form of a pilot project aiming to redesign an existing product in the form of a control cabin, with the intent on refining an existing product in order to add value to existing business revenue streams, shown in Stage 1 of Figure 21.

The project focused on redesigning a control cabin for a subsea vehicle and involved extensive research in order to understand the experiences of workers responsible for piloting these vehicles, before creating a prototype unit. This project proved to be a success and the senior management team made the commitment to introduce design by utilising an external innovation space (Stage 2) and commissioning a strand of work that specifically focused on the business opportunities surrounding autonomous technology (Stage 3). This work was strategic in nature and involved mapping the existing operating processes of the organisation, with a view to understand the time and cost implications of various changes to the existing innovation process with respect to facing the challenges surrounding a market trend towards automation.

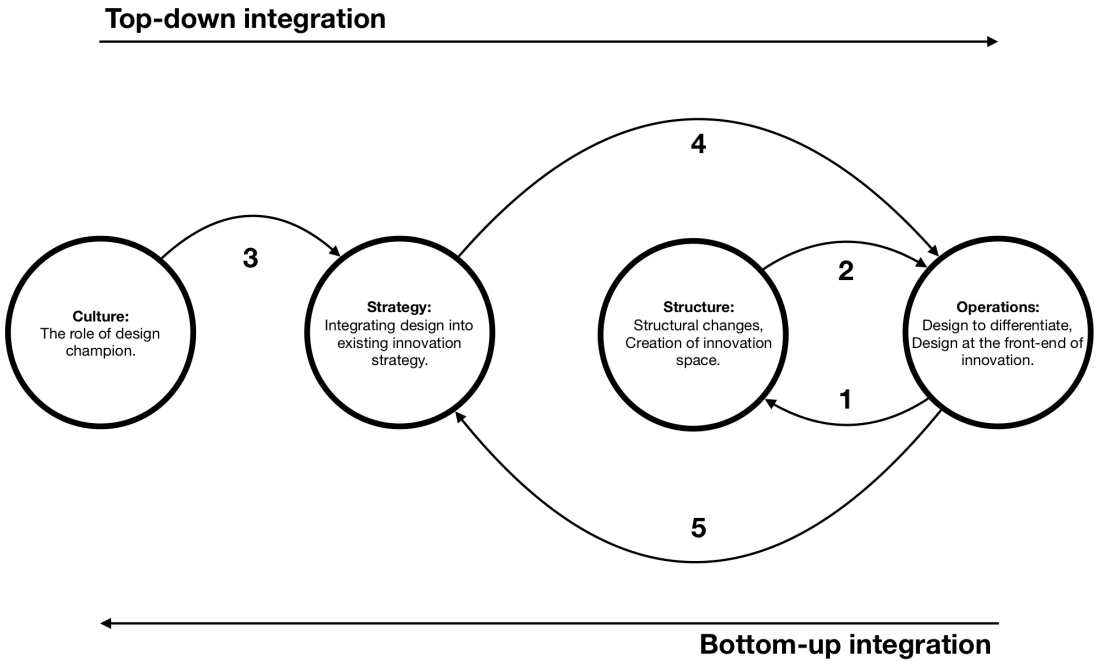


Figure 21: Integration within Organisation C

This work let to Stage 4, the identification of opportunities for the company to exploit immediately, as well as opportunities that the company could seek to exploit in the future. This was supplemented with the identification of capabilities that needed to be developed in order to successfully exploit these opportunities (Stage 5). Whilst design was able to impact the strategy of the organisation through this process, it was unable to embed itself within the wider culture of the organisation, specifically because of multidisciplinary conflicts that stemmed from the reluctance of middle managers in the engineering department to engage with the new design processes.

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Design Strategy	0	0	0	0	1
Design Programming	0	1	2	2	2
Design Delivery	0	0	1	2	2
Design to Innovate	0	0	2	3	3
Design to Differentiate	0	0	0	0	0
Design to Optimise	1	1	2	2	2

Design Skills	0	0	0	0	0
Competence Development	0	0	0	0	0
Culture for design	1	1	1/2	1/2	1/2

Table 12: Changes to maturity within Organisation C

7.5.4 Idealised version of the framework

Whilst Figure 18 represents the current best explanation for the integration of DLI, findings from the individual cases suggest that there is a potential for additional linkages to be explored throughout further research, with the goal of creating an idealised version of the framework going forward. Additionally, it is difficult to suggest at this stage the number of cycles an organisation would need to carry out in order to integrate DLI at a cultural level. This is dependent on several factors, including the way in which design is introduced (top-down or bottom-up) and the extent to which barriers and enablers are present within an organisation. Figure 22 visualises a potential idealised version of the framework based on the key findings of this research.

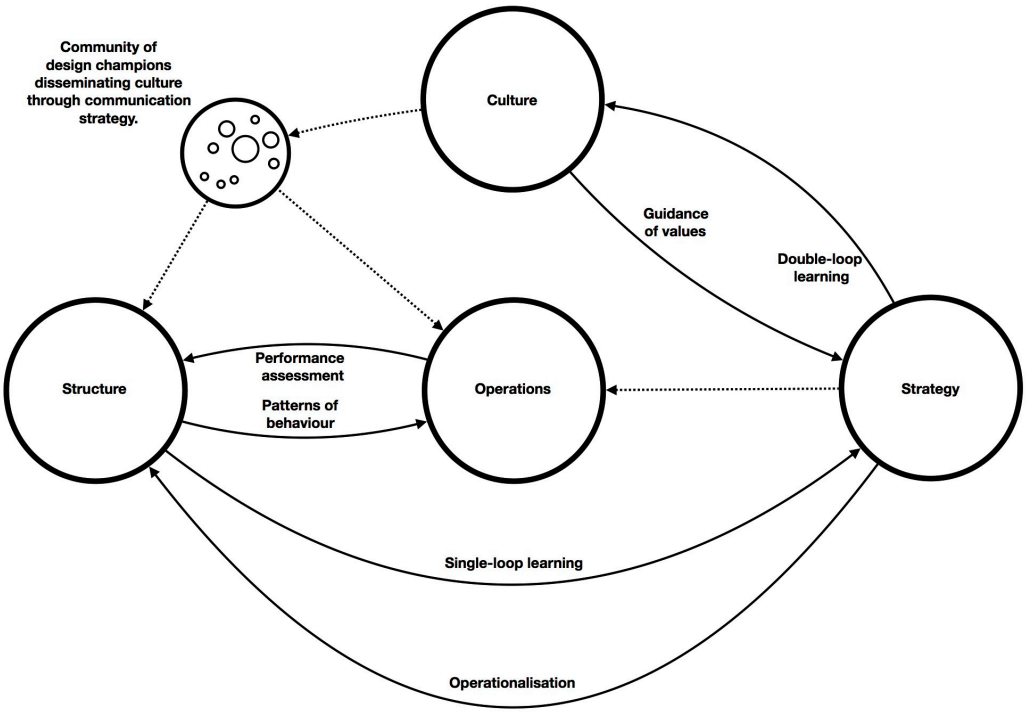


Figure 22: Potential idealised version of culture framework

The intent of Figure 22 is to demonstrate a fluid framework that is capable of describing the cycles involved in the integration of DLI. In particular, Figure 22 recognises the

impact that a community of design champions is capable of having on the integration process, primarily in disseminating a wider organisational culture that is supportive of DLI. A community of design champions has the potential to act as a bridge between a desired organisational culture and the additional areas of the organisation, which is not necessarily reflected within the original framework. This framework offers a starting point for potential future research, whereby work could utilise the framework to specifically identify the cycles that occur as design is being integrated. Furthermore, work should seek to identify the time scales attached to each cycle as well as the relationship between barriers and enablers that are critical at each phase.

8.0 Conclusion

Chapter 7.0 discussed the findings of the study in relation to relevant literature in order to create a theoretical framework capable of describing the integration of DLI within science and technology-led multinational organisations. This chapter aims to draw conclusions from these findings and discuss the implications that the research has for both theory and practice. The chapter will also specify the contribution to knowledge derived from the study, as well as outlining the limitations of the research approach and recommendations for future research.

8.1 Implications for theory

There are multiple implications for theory that have emerged throughout the course of this research. These implications relate to the collection and analysis of data, as well as the findings derived from each of the cases in relation to previous research. This section aims to make these implications explicit through a summary of key discussion points.

8.1.1 Data analysis and adaptation of Philips framework

The analysis process adopted the Philips framework, derived by Gardien and Gilsing (2013), in order to categorise the findings based on the maturity of design integration across each of the three case studies. This research has furthered the development of the framework by identifying additional areas that can be added to it, in order to broaden its applicability for research seeking to understand the integration of DLI in organisations where there is no formal design resource prior to attempts to introduce the discipline. This was achieved through the introduction of a ‘maturity level 0’ category based on the work of Aftab (2013), who describes a similar period in Philips’ history in which design acted as an auxiliary support function in relation to other functions within the organisation. This data was utilised in conjunction with the initial framework of Garden and Gilsing (2013) in order to expand the framework so that it covered the initial stages of integration in the cases present in this research. Furthermore, statements were added to the framework based on findings that appeared in multiple cases yet were not accurately depicted in the initial framework. The results of this process are documented in Figure 8 and provide a more complete version of the framework to be used in future research, which looks to provide additional detail in assessing the maturity of design practice across multinational organisations.

On reflection, the choice to adapt and utilise the Philips framework for the purposes of analysing the dataset appears to have been a success within the context of the study.

The framework itself was chosen due to the detail surrounding the development of design across maturity levels, as well as the similarity between Philips as a technology driven organisation and the three cases that took part in the research study. Throughout the analysis process, there were very few statements that could not be categorised into the adapted version of the framework, further highlighting its suitability for similar research in the future.

8.1.2 Identification of barriers and enablers to design-led innovation

The results of the data provided specific insight into barriers and enablers to DLI that occurred in each of the cases, shown in Tables 8 and 9. Carlgren *et al*. (2016) identify several barriers to design thinking across larger organisations, however they suggested that more research is needed to be carried out in order to investigate the way in which design thinking is integrated and how it impacts these barriers, whilst also expressing a need for research that provides examples of ways that companies have handled barriers. This was echoed by De Goey *et al*. (2016a) who also claimed the need for research that focuses on the relationship between barriers and enablers across various phases of design-driven innovation. The findings of this study bridge this gap by highlighting barriers and enablers to DLI across three multinational science and technology driven organisations, as seen in Appendix G. Furthermore, the work has provided examples of instances in which barriers have been overcome, which has ultimately led to the development of a framework that provides a holistic view of critical factors and actions necessary for the successful integration of DLI.

8.1.3 Reaffirms the role of design champion

The research has also demonstrated that the role of a design champion was important across each of the three cases, which adds further evidence to the work of authors such as Holland and Lam (2014), Hands (2009) and Martin (2009). Specifically, the role of design champion was particularly important in providing the design functions with the time and space necessary to establish itself as a discipline across each organisation as well as being an important factor in ensuring that the design resource was adequately funded. Similar findings have been seen within the context of social innovation and community based projects (Cooper, 2004), which suggests the potential for a design champion being a generic requirement for successful design projects, however further research is needed to support this hypothesis.

Typically within the literature, the role of a design champion is seen as important in communicating the value of design at the strategic level of an organisation, however this research has also found that the presence of a design champion at the operational level can also have a positive impact on the absorption of DLI. This was particularly

prevalent in Organisation A, where the marketing and engineering managers took up the role at different times to communicate the value of design to various people across the business. The marketing manager often championed the discipline to senior figures across the company, which was important in securing necessary finance and resources for design to be established. Conversely, the engineering manager was critical in championing the discipline to employees at the operational level, which was a significant factor in overcoming multidisciplinary barriers caused by resistance, driven by a fear of job losses. This is significant as it suggests the need for a broader focus on the impact of a design champion, in particular in relation to overcoming barriers to implementation at the operational level. Furthermore, Appendix G suggests that the presence of barriers surrounding multidisciplinary conflicts are often present in the initial stages of design's introduction, therefore it is also worth recommending the presence of a design champion at the beginning of a design intervention in order to maximise the limitation of these barriers.

8.1.4 Examples of double-loop learning in an organisational context

In section 7.1, double-loop learning was discussed as a methodology for creating a deeper level of reflection within an organisation, leading to cultural level change. This occurs in situations where organisations improve their inner values such as the underlying assumptions behind existing techniques, goals and values to understand why they do what they do. Recent studies have had an increasing focus on the importance of double-loop learning within the context of design management (Wolff *et al.*, 2016), however this type of research has not yet been supported with examples of instances where double-loop learning has occurred.

Throughout the three case studies, double-loop learning was necessary to absorb new capabilities, by undertaking cultural shifts to generate an acceptance of DLI. Thought the development of a cultural framework, this research has demonstrated the factors that are necessary for double-loop learning to occur based on insights from three cases in which cultural shifts have occurred. In particular, these cultural shifts were present after overcoming multidisciplinary conflicts by consistently expressing the business value that design can add to an organisation, as well as reassuring other functions that their role would not be diminished upon the introduction of design practice.

8.1.5 Office space as a reflection of culture

Within organisation research the role of office space is generally regarded as important for the development of a specific organisational culture. This research has considered the impact that office space can have on the introduction of DLI, with organisations adopting a strategy of developing spaces capable of facilitating this type of work, primarily in the early stages of overall integration. The benefits of having a specific

design space are various, with the impact ranging from providing a space to facilitate brainstorming and creative meetings to providing separation between the function and current organisational practices that are proving to be unsuccessful. These findings, discussed in Section 7.2.2b, suggest that office space has the ability to provide a visual representation of the DLI process, acting as a constant reminder of design's presence to everyone in the workplace. The space can also be used to facilitate DLI practices, by containing toolkits that are accessible to anyone using the space.

8.2 Implications for practice

The creation of a framework that documents the relationship between several important factors in integrating DLI has various implications for design practice.
In particular the research has implications for design managers who are responsible for carrying out this type of integration across organisations. Furthermore there are implications for policy making organisations, such as the Danish Design Centre and Design Management Institute, who advocate the use of DLI but currently only provide vague information surrounding the integration of the discipline outside of suggesting that firms acquire an internal design resource. This section aims to make these implications explicit.

8.2.1 Short-term success is key for successful design-led innovation

Whilst a long-term goal of integrating DLI into an organisation's innovation processes is at the core of this research, the importance of successful short-term projects in achieving this goal cannot be overstated. Using design in a strategic manner is a longer-term pursuit that is unlikely to provide returns in a short space of time. In organisations where there is scepticism surrounding the discipline of design, the discipline may not be afforded the necessary time and space to carry out successful projects at the strategic level without building on previous successes. Organisation C demonstrated that design can be utilised at the strategic level from the outset of integration, however this has led to numerous barriers at the operational level that remained in place over the course of the study. Many of these barriers proved to be difficult to overcome by championing design as a strategic discipline, therefore a better approach would perhaps have focused on achieving 'quick wins' through projects at the operational level prior to or alongside the strategic level work. This approach was successful within Organisation A where successes quickly validated the approach of the design team amongst the operations level of the organisation, allowing it to develop as a strategic discipline without barriers surrounding a lack of understanding of the discipline and multidisciplinary conflicts.

8.2.2 Purposeful restructure can significantly reduce barriers

Organisational restructure played an important role across each of the three case studies, however many of the positive effects of restructure were unintended side-effects as opposed to intentional benefits. It is clear that organisational restructure can have an impact on the reduction of barriers surrounding DLI, therefore it is a potential tool that strategic managers can harness in efforts to integrate the discipline. The research has demonstrated that restructure offers the potential to increase design's capacity to engage with customers as well as increase and coordinate design resource across an organisation.

Strategic leaders could therefore use a process of restructure to overcome these challenges within their own organisations, or build on this further by performing an audit in order to map out existing barriers to DLI, before considering how restructure could impact these barriers. In order for strategic leaders to implement these changes, however, findings from Organisation A suggest that design must be at a stage where it has progressively proven its value through successful projects in order for restructure decisions to be based on the merits of the discipline. Otherwise, there is potential for restructure to seem like a political power and influence move by design at the strategic level of the organisation, to increase its influence over the strategic decision making process. This is especially the case for organisations where design has no influence at the strategic level of the organisation prior to attempts to integrate design as a function through DLI.

8.2.3 Internalised design processes are important

In order to establish a design function, design processes need to be internalised to create a strong foundation of in-house design capability. Organisation B in particular highlighted the importance of this by suggesting that it was a critical factor in establishing the design function. Bringing these capabilities in-house meant that the function had the capability to lead innovation workshops in ways that it had not been able to previously. An internalised design process also adds a sense of validity to the work and provides other disciplines with an understanding that design is an integral part of the organisation's innovation strategy.

8.2.4 Integrated top-down and bottom-up approach

The research suggests that a combination of top-down and bottom-up approaches is the optimal method of integrating design to overcome barriers at the strategic and operational levels of an organisation simultaneously. This has implications depending on the initial stimulus for integrating DLI. In situations where the stimulus is initially top-down, strategic level leaders should seek to engage with the operational level as early as possible to achieve successful projects in a shorter time-period. Without this support, it is likely that barriers at the operational level will remain in place, as seen in

the case of Organisation C in relation to overcoming multidisciplinary conflicts. Where a bottom-up approach is initially favoured, design managers should aim to get the support of a design champion in a strategic level position as soon as possible. Key to achieving this type of support is effectively communicating the benefits of successful smaller design projects. Organisation A provides a positive example of this process, whereby the successful design projects at the operational level were intelligently communicated to senior management from the early stages of integration, gathering support at the executive level, which greatly impacted the ability of the function to gain influence throughout the organisation.

8.2.5 The presence of a design specialist

The presence of a design specialist also appears to be a prerequisite for successful DLI and is a critical feature of the three case studies. Across each of the three cases documented in this study, the specialism has occurred in the form of a University or external design consultants. Organisation A utilised a University and a KTP project in order to acquire the necessary design resource to initiate this type of integration. Similarly, Organisation C utilised a University and an external design consultant at the beginning of the work as they had little in the way of internal design resource, employing only one industrial designer.

Organisation B breaks this trend, in that they had an internal design resource at the beginning of the study, however they still required the presence of external specialists in the form of a University and external design consultants in order to integrate design at the strategic-level of the organisation. This suggests that a certain level of design capability is necessary in order to fully integrate DLI at the strategic level of organisations and perhaps act as a catalyst for embedding design at the operational level. This has implications for strategic leaders seeking to integrate DLI, as it suggests that employing external design specialists would be a worthwhile use of resources.

Although these cases have all utilised an external design resource in addition to their internal design teams, there is not enough data to indicate whether it is possible to build this level of capability internally and therefore not rely on the presence of external design specialists. This is another potential area for additional research in the future.

8.2.6 Benefits to innovation policy

Gorb and Dumas (1987) coined the term silent design in order to describe design activity being carried out by people who are not designers and are not aware that they are participating in a design activity. Within the context of businesses, this notion is also apparent in instances where the contributions of design professionals to business

success can often be invisible and rarely acknowledged. More recently, Chatzakis (2015) refers to this phenomenon as obscure design, whereby design tasks may be difficult to describe within the context of day-to-day business. The frameworks developed throughout this study provide clarity to some of this design activity and as a result could be beneficial in helping organisations to better frame their existing design practices and capabilities. In this respect, it overcomes the challenges surrounding existing maturity frameworks, in particular those that assume businesses have no design capability. Oftentimes, businesses are carrying out these activities but without formally defining them within innovation processes, as highlighted in a discussion of the Danish Design Ladder present in Section 3.2.

8.2.7 Understanding the maturity of design as it is integrated

Tables 10, 11 and 12 provide an analysis of maturity across each of the three cases as design is introduced based on specific stages of integration. This process provides an opportunity for organisations to reflect on the way in which design is being introduced in real time. In particular, it allows organisations to reflect on the relationship between barriers and enablers to design-led innovation at different stages of maturity, as design is being introduced. This dynamic interpretation of design-led innovation is of value to organisations, who have the opportunity to use the framework in multiple ways as they go about integrating DLI into their organisations. Firstly, it can be used at the beginning of DLI's integration in order to understand the way in which design might be introduced over time, providing an understanding as to the ways in which maturity will change as barriers and enablers occur within day-to-day organisational practices. Secondly, the model can be used to benchmark progress as DLI is introduced, perhaps in order to determine whether progress is being made in line with that of similar organisations. Finally, the tool can act as a useful facilitator of reflection once DLI has been introduced into organisational practices. In doing this, it can act as a catalyst for further double-loop learning within the organisation context, further embedding design into organisational culture.

8.3 Contribution to knowledge

In order to state the contribution to knowledge made by this study, it is worthwhile to revisit the focal research question of 'how do multinational science and technology-led organisations adopt design-led approaches to innovation?' The insights gained through the theory and practice-based implications have led to the development of a framework that is capable of providing an insight into the way that each of the three case studies integrate DLI practices, shown in Figure 18.

The literature review outlined current gaps within research surrounding the documentation of the processes involved in the integration of DLI across organisations. Research into the area generally is in its infancy and existing maturity frameworks are not being utilised to document how organisations are going about adopting DLI. Instead, they are a source of information that aims to highlight the value that design can provide to businesses depending on the level to which it is integrated (Chapter 3.0). Furthermore, existing frameworks have been described as static (Acklin, 2013), because they fail to take into account the way in which the role of design changes over time as it is absorbed by organisations. Similarly, there appears to be a skewed focus towards DLI as a tool for improving the competitiveness of small and medium sized enterprises, leaving room for increased research that seeks to understand these perspectives within multinational sized organisations.

This thesis has sought to provide insight into these areas, culminating in the creation of a framework shown in Figure 18. The framework provides an understanding of the commonalities present across three multinational science and technology-driven organisations who have gone about integrating DLI into their current operational practices. In particular, the framework focuses on aspects of organisational culture and structure that were important in implementing DLI across each case. To achieve this, the analysis process highlighted various barriers and enablers to DLI that were pertinent within each case as well as considering how they changed over time in relation to the way that design's maturity also improved. This analysis process aimed to overcome criticisms of previous work in particular the creation of frameworks that were described as static due to their inflexibility in describing how factors changed as the influence of design increases over time.

Most importantly, the framework demonstrates the relationship between the complex factors involved in integrating the discipline of design into innovation practices. In the past, some of these factors have been discussed in isolation, however showing the relationship between cultural factors indicates that there may be areas of unintended consequences that make overcoming problematic barriers possible. For example, having several successful examples of design that are communicated succinctly across the organisation is effective in allaying the fears of disgruntled employees from other disciplines that don't understand the impact that design can have on business value. Similarly, much of the initial resistance surrounding the introduction of design stems from a fear of job losses from existing disciplines and also a fear that they will be missing out on activities that they find stimulating, such as the inception of new ideas. Having the ability to recognise the impact that indirect activities can have on particular barriers to DLI is especially valuable to organisation's seeking to implement DLI in the future. Specifically because it provides the ability to foresee barriers and have an understanding of ways in which barriers can be overcome through interventions in

areas of the business that aren't necessarily in direct connection to the area in which the problem is present.

Finally, research of this scale that seeks to understand the introduction of DLI within multinational science and technology driven organisations is in itself a contribution to knowledge. Much of the existing literature seeks to understand design within the context of small and medium sized enterprises, whilst research into multinational firms does not specifically pinpoint the science or technology sectors. Throughout the research process, in particular during the recruitment stage, it has been the case that science and technology focused organisations were most willing to engage with the work. This suggests that there is an inherent interest in DLI practices from organisations within this sector, as opposed to other sectors that were approached to be part of the research. As a result, the work offers value to organisations within a sector that is likely to be open to engagement with DLI in connection with existing innovation processes.

8.4 Limitations of the research approach

The availability of organisations to take part in the research was influential on the final study design. It was apparent early on that science and technology oriented organisations were most interested in engaging with the study, in particular organisations who already had connections to Northumbria University in some way. This greatly influenced the selection of cases, as availability and interest to take part in the study were critical criteria in participant engagement.

The involvement of the University across each of the three cases, however, also led to further limitations of the research approach. Initially, the University involvement led to a lack of control over how the data was being collected as there was little scope to impact the way in which the projects were being carried out. Simultaneously, the University involvement meant that there was a larger number of variables that had to be considered as the data collection was carried out in order to determine whether factors occurred specifically as a result of the University engagement.

The University involvement also meant that the projects were not necessarily a true representation of the way in which projects are carried out across industry. Factors such as the time scales of integration were dependent on the way in which projects were coordinated between the organisations and University. In particular, the availability of staff in each case had the potential to impact timescales, as well as pressures surrounding University term cycles. Had the organisations solely enlisted the help of external design consultants rather than a University, some of these restrictions would not necessarily have existed.

Although the involvement of the University as an institution was consistent across each study, different academics were involved in each case, with different methods of implementing DLI also utilised in each circumstance. This somewhat mitigates the effect of the University involvement, however future research would be valuable to corroborate the claims made in this research in instances where the role of the University is held by external consultants, perhaps answering the question of whether a University is capable of stimulating change within an organisation in a similar way to that of an external design consultancy?

Furthermore, there are limitations to the research approach surrounding the time and resources available to complete the project. At the completion of the data collection stage within the research, Organisation C was midway through the integration process. In this instance, it would have been valuable to follow the progress of the company over a longer period of time in order to ensure greater consistency alongside cases A and B. The ideal scenario would be to follow multiple organisations over the same timescale as they attempted to integrate DLI into their innovation practices, however this was not possible within the scope of this study.

8.5 Areas for further research

As the research concludes, there are several areas that appear to be worthy of consideration within further research. These areas are outlined within this section.

8.5.1 Further testing of the final framework

Chapter 7.0 concludes with a discussion of the theoretical framework in relation to the observations made throughout the research. The logical progression of the research is to test the framework further within another multinational science or technology-led corporation that is integrating DLI for the first time, in order to refine the connections between barriers and enablers to DLI as it is integrated.

This process would then open up scope for further research that aims to determine whether these findings are applicable to organisations from a broader range of industries. Firstly, this would involve testing the generalisability of the framework across other types of multinational organisation outside of the science and technology sectors. Similarly, research could be carried out to determine whether the findings are applicable to different organisation types, in particular Small and Medium sized enterprises who likely face a different set of barriers in integrating design practice into their innovation procedures.

8.5.2 Further exploration of suitable methods

The research methodology, Chapter 4.0, outlined two different approaches that would have perhaps been more favourable in collecting the data for the research: action research and repertory grid interviews. The intention of setting up an internship within an organisation was to provide the researcher with a scenario whereby reflective practice could be utilised to understand features of tacit knowledge that are important in implementing design-led approaches to innovation. Ultimately this proved to be a difficult task within the scope of this project, with organisations reluctant to engage with the work to the extent that would be necessary in order to carry out this approach. Subsequently, the final data set focused on explicit knowledge, which people were capable of expressing through semi-structured interviews, as opposed to more tacit-based knowledge developed through an action research approach.

Similarly the application of the repertory grid interview process was limited by the timescale of the project, with it being necessary to spend further time refining the method in order for it to be suitable for the purpose of the research. Again, further refinement of the repertory grid framework is an interesting area available for future research, with its successful application having potential for understanding tacit knowledge within a design process that is notoriously difficult to examine and explain.

8.5.3 Exploring the origins of a design champion

One of the critical features of the final framework is the presence of a design champion, who is able to facilitate the introduction of DLI by championing the discipline at the strategic level of an organisation, as well as by communicating the benefits of the discipline to sceptics at the operational level. Across each of the three cases, people have assumed the role of design champion because they felt that the discipline had the potential to improve the organisations that they are partly responsible for. Interestingly, each of the design champions had a different relationship with the discipline upon its initial integration into the organisation. Some champions, such as the VP of Packaging within Organisation B, had originated from a design background and had developed an understanding of the discipline through years of practice based learning. Within Organisations A and C, however, the role of design champion was taken up by people who had no formal training in design and whose experience of the discipline was limited prior to witnessing smaller scale projects within the participating organisations.

This difference raises questions surrounding the origins of design champions within firms, particularly the reasoning behind their positive stance on the discipline. Literature has evaluated the role of the design champion, however no studies appear to investigate the relationship between the champion and the discipline. It could be

interesting to determine whether it is beneficial for champions to have had some sort of formal design training, or whether it is more effective for champions to originate from other disciplines as design is communicated throughout organisations. It is possible that prior relationships with the discipline have an impact on the way in which DLI is integrated across an organisation, in particular the time it takes to carry out this initial integration. It could also be interesting to determine whether champions from alternative disciplines find it easier to overcome barriers and communicate the benefits of design without appearing biased towards their specialist discipline.

8.5.4 Exploring atypical barriers and enablers to design-led innovation

Finally, further research could be carried out with a focus on investigating barriers and enablers that were not consistent across the three case studies. Features such as a lack of agility, risk surrounding the loss of tacit knowledge and supply chain restrictions could all merit further investigation to determine whether these factors are prevalent in more organisations, if there is enough evidence to generalise in the future and also whether it is possible to determine why these factors were not present across other case studies within this study.

8.6 Concluding summary

Chapter 8.0 began by outlining the implications of the research for advancing theory surrounding DLI. The implications related to the way in which the data set was collected and analysed, as well as the findings from the study itself. This was followed by a discussion of the implications that the research has for practicing design leaders and managers, in particular those with intentions to increase the influence of the design discipline within the existing innovation strategy of an organisation.

The chapter then outlines the contribution to knowledge derived from the research process, in particular the creation of a framework that is capable of documenting the relationship between cultural factors as DLI is integrated into organisational innovation processes. This approach is beneficial in comparison to previous studies, as it places an emphasis on the relationship between individual factors as well as the fluid way in which this relationship changes over time.

Finally limitations of the research approach are considered, including the methodological limitations that occurred throughout the study. This process has led to the identification of multiple streams for future research that could be carried out in order to strengthen the findings of this study and progress the field further in the future.

Appendix

Appendix A: Transcript samples

Organisation A: Isaac

JG: So the questions that I have today are about design generally within Organisation A and also how you went about certain things during the KTP. To start with, can you describe the organisation?

Isaac: Yeah well the organisation is an engineering-led company, a corporate company based in America. So Organisation A is the corporate company, they are engineering specialists, they do anything relating to motion control technologies which can extent from what we specialise in which is filtration, to valves, engines, motors and the kind of things that you don't see a lot of stuff although it is a massive company, I think it has a thirteen billion per year turnover. But they do a lot of under the hood stuff really for other companies, so they sell a lot of business to business applications. Us as the acquisition of Organisation A, our division specialises in compressed air and gas filtration. In a nutshell, that's wherever you see compressed air used is the bread and butter of the company, so pneumatics, anything that is pneumatically powered without filtration can get damaged so that's an aspect. They have various different products that can filter the equipment so they have big driers and then smaller and they set that up as a system. But there's other markets as well that have extended from that and includes other gas filtration that is necessary. So another example is CO2, we develop filtration for CO2 for the likes of coca-cola and other soft drink companies so that's another area that we go into. That's one platform for our division but the other platform is gas generation, so that's not just filtration, that's essentially using some of the filtration but we generate various gasses, one of our main one includes nitrogen so we have a larger nitrogen generated and some smaller related products. Have I went a bit off track?

JG: No its fine, its good to get an insight into generally what's going on there. What's your official role now? The KTP is finished hasn't it?

I: My role is the industrial designer in the company, I'm the only one actually.

JG: How long have you been in that role?

I: Two and a half years ish, the KTP ended in July this year so that would have been the full two years and then I've been working officially between the company since then.

JG: What are the key responsibilities that you have then?

I: Well I've kind of built my own role through the KTP so I've developed my own responsibilities. How I see it is that I look at more of the front end of the design, so the early concept development. I try not to go towards the final end of development as that can be implemented really well by the engineering team. There's a few things that I do really. I facilitate creative brainstorms to see if I can facilitate creative outside of the box thinking within the company, trying to think of other ways that we can tackle a solution in ways that wouldn't be done using lateral thinking. Also, I'm more user centred and customer centric, so within the engineering team, they aren't very customer facing whereas marketing is. So I'm kind of the middle ground between marketing and engineering, so I'm kind of translating that information. So I'll go out to the customer and try to identify what problems there are before trying to say that we can provide one of our products for you. I'll try and find out exactly what the end needs are for the end user. Once I've found that information out and done my research, we'll then go and

have a creative brainstorm with the right members of the team and try to include the customer as well. From that I'll develop a range of concept sketches. So as I've mentioned my role is very much the first stage of it but I'm also mostly doing concept sketches and a little bit of cad and 3d prototypes as well in those early stages. I wouldn't go as far as technical drawings.

JG: A little bit of a side question but did you receive any design training from Organisation A at any point?

I: Yeah, I'm due some CAD training soon which I can get on to. I've had various other things, I've had excel training which I opted in for, I've had training on Indesign, a thing called high performance team training, essentially working in high performance teams and toolkits to help you do that, although that isn't specific to industrial design whatsoever that's just a general thing that I decided to incorporate. So yeah there's been quite a few things like that really, they are open to letting you do what you want.

JG: Ok great. Thinking about design generally within Organisation A, can you describe the role that it plays within the innovation process?

I: Yeah I mean the role that it kind of plays is, I think my role for innovation is the out of the box thinking. I look at innovation as how can we come up with a new technology that outperforms somethings else, but that's kind of what R&D focus on. I'm looking at more of a customer focus, making something outperform our competitors because its catered to our customers and it does something that no one else does by being a better product.

JG: Have you seen a change in design's role since the beginning of the KTP?

I: Yeah there's been quite a significant change actually, in the physical environment for one thing and general attitudes towards industrial design. The physical environment has changed and I can't say its a direct link but it has had an effect because one thing that I tried to embed was that we didn't have an actual space for innovation, we just had general meeting rooms that weren't really set up for it. So these meeting rooms were booked and used for everything from a customer meeting to checking up on projects. The one thing that I tried to incorporate was actually now a physical room called the ideas lab which is a space with a big whiteboard, computer, loads of chairs and it has a toolkit in there for brainstorming so you can write on the windows and things like that, its got a glass wall, it can't be booked. So if you really want to use it you just put a post it on the window and let people know, then people can kind of jump in and out. It sits in between marketing and engineering so its not secluded within one department. So that's one thing, we developed the space and it stood out a bit, the whole bottom floor got revamped as a result. Attitudes have also changed, because its an engineering-led company and it always had been, at the start they didn't recognise industrial design, what it was or what my role was so I've basically had to build trust over the past two years by proving what it is through projects or actually working with them and I think they kind of get it now. I think the original persona that they had on industrial design was that I was there to make their products look nice, but I think that's because some of the original work that they did with the uni kind of was that, attached at the end, using industrial design at the very end once the major decisions had been made. Its changed now purely from my presentations where I've proven it in projects and they know that its not all about that and it works much more effectively when I can get at the front of the design process before we've actually started thinking about what we're going to design. We're talking to the customer and thinking about early feedback. It is used like that, there's been a few projects early on where I've been thrown in at the end and it hasn't worked or it hasn't been as effective as it has been in others where I've been there at the start. But people are recognising that now, they're not saying that I'm the fashion police or anything like that so its changed completely.

JG: Ok to come back to a couple of things there, the toolkits that you mentioned, is that something that you've created?

I: So I'm working on a physical tool kit at the moment, although it might not be out there until next year. I've done an interactive PDF that I'm yet to roll out but its for brainstorming. Because I'm the only industrial designer, its to try and encourage other people to brainstorm in the right way. The kind of stuff that IDEO generate, where people have to draw on post it notes and follow the rules and all that. So that's what I'm trying to do and people have been involved in that and get the idea of it so I'm trying to roll it out with a digital toolkit where you can click links which will bring up templates that you can print out or posters or warm up activity examples. So that's the toolkit, but I eventually want take this interactive PDF and to turn that into a physical thing with little booklets. Its a bit slow the process but I'm working with the marketing communications team to maybe develop something that comes in a physical box with post it notes and markers and things like that. I want to make that a key thing, a key aspect of the ideas lab area.

JG: Great, coming back to the other thing you mentioned before that at the beginning you were thrown in at the end of projects, was there a tipping point where they changed focus and started to bring you in earlier?

I: I don't know if there was an actual tipping point but if there was its hard to pinpoint. Actually, there was one project in particular where I strongly, I don't want to say whinged, but advised that design could have been better earlier on. It was a project that has actually recently been launched, its a medium flow dryer. Its a large filter that takes out air moisture. My role within that was that they needed a fascia on it which was going to originally have an interactive screen on it sat in between two columns. So you'd have two columns standing next to each other with this on the front. But the columns were designed by an engineer and my role was just to design a shroud around the whole thing and it ended up being two different variants of the fascia because there was a two column version and a three column version but the fascia couldn't fit around the three column version properly. But a lot of the design had already been finalised and there wasn't time to make drastic changes but my advice on that would have been to put that third column at the back so then we could have had a unified family looking feel and have also saved on cost. So I think from that there's not really been many major products where I've been put in towards the end its mostly been at the start. Actually, thinking back to it, it could have been when we got a new manager in thinking about it. There was a new engineering manager that came in about a year ago and he used to work for a company which already utilised industrial design so he kind of already had an idea of what industrial design was so it was easier for me to bounce off him compared to how he saw it. This time last year I was writing down my design process and developing a working map to show where industrial design sits and I think by having that I'd say this is where industrial design sits, its definitely at the beginning not towards the end. From then we've acknowledged that the next five projects that I'm going to be involved in, that are going to be my major projects for next year and from that I know that I'm going to be involved at the start because they haven't started development on them just yet. So I think yeah its probably to do with when the new manager came in, he was also looking at product road maps as well.

JG: Thinking about the culture of the place, has that changed since you started off?

I: Its been difficult because its quite a slow process, our company anyways, in getting a new product out of the door. I think that goes with it being quite a corporate company as well as having lots of testing and regulation for our products. So really, when it comes to industrial design I can get involved at the front. I'm trying to think of your question, I think I've gone off track a bit…

JG: Yeah so basically some of the other organisations that I've been working with have found it difficult to change ways of thinking surrounding certain aspects of the kind of innovation process if you like, they are used to a linear

process with engineering being one of the dominant process. I'm wondering what that's like for you especially being the only designer in there. Did you come up against similar challenges and if you did how did you overcome them?

I: Yeah I think it has probably changed a little for the better but its not 100% there and it isn't easy. It is quite linear but its mean to start from marketing defining what the next series of projects will be and they decide so in five years we'll need a new filter series so that's set up already.

JG: Do you have any role in that process?

I: So we are focusing on CO2 filtration, so I can't decide for them, I have to really prove that it'd be good value for the business to do a new project and that would be quite a tough thing.

JG: So will they give you an area to focus on?

I: Yeah and that's where my involvement would be. In this new product range for example, rather than having a static filter that would work in exactly the same way as before I'd look at a different way of using it and that's where the innovation comes in. The difficulty with me is that you've got people tasked with different metrics to you, so I really need to sell the value of this feature. Its hard to talk about because we're still waiting for patents but its been prototyped and tested on customers and it will completely change things for that range and its something that no one else is doing and there's loads of value in it. The difficulty is that you have costs associated with it, people fighting against is saying that we know the other version works so we're safer going with that option. So its quite hard to actually push for drastic innovation purely because of the way the company is set out.

JG: What's the view of risk then, within the innovation process generally?

I: I think its very low risk.

JG: Do you have different departments with different outlooks on that, or who are the people driving it?

I: I'd say R&D in particular have loads of ideas that are tried and tested, but they face similar challenges to me where they've passed it on to management for the next project who've written it off because there's cost implications involved or its too risky. It is quite a risk averse company and to be honest, in the last two years I've been working there it hasn't really changed. I'm still facing difficulties pushing the more extreme concepts through the door but I'm trying to stay positive on that really. I think its hard to say exactly why that is but I think its more to do with the politics of the company and the different divisions.

JG: To what extent are people generally supportive of design within the company?

I: Actually, they are really supportive of it. I've kind of proven that it works, even with the likes of the new dryer that we've developed although I still think it could have been better if I was involved at the start, the outlook on it is completely different now and people appreciate that now. Also if I invite people to brainstorms now I'm getting a lot more positive response and people are turning up. People like being taken away from their day-to-day role, some of them have been working on the same project for two and a half years now so they enjoy the change.

JG: Has that changed since you started there again?

I: I think it has, its got easier. People have stopped rolling their eyes thinking I'm an overpaid engineer just trying to change the colour now they see that its about

innovation. Its hard to get innovation through the door, its hard for other people like R&D as well but it doesn't mean that we stop that, we have to try and be forward thinking and I think that people do recognise that now. There was already a lot of positivity from marketing in the beginning because I helped marketing out a lot so it was an easy sell of industrial design to marketing because they can then go off to the customers and have new ideas based around them.

JG: What's that relationship like between marketing and industrial design?

I: Yeah its good. When I started I was initially put with marketing because they weren't quite sure where to place industrial design so the relationship has always been positive, they get it, they understand and I get asked quite a lot to join in on projects more than engineering because they aren't quite as forward thinking for the business if that makes sense. They will be working on something that they are already tasked with, so they naturally won't give that up to focus on something completely different so for the engineering side I need to dictate that. Whereas marketing will come to me and say look we've found some new business here, can we do something with the customer that will help them so I suppose I'm getting more out of marketing and with engineering I'm still putting more in to try and prove my value. I know its an engineering led company but the decisions will come from marketing as well, marketing will say this is our next product range, this is what we're going to do and engineering will simply align their resources to that to find a solution.

JG: You mentioned that you were initially put in with marketing, how long did it take for them to recognise you as a different entity?

I: It tied in actually with when the new engineering manager came in, it was on his say. At the beginning I actually thought I'd be part of engineering. Because they have design engineers so being an industrial designer in with those made sense. But with it being a KTP, the way I was employed, the guy facilitating it was the marketing manager so I just stuck with those really, I was naturally put into marketing because of that. But over time I think my vision was swayed a bit into thinking it was more of a marketing tool because they are customer facing, industrial design is customer facing and I'm not really doing as much technical work as engineering so I kind of was believing that it fit in with marketing. But when the new engineering manager came in, just over a year ago now…

JG: Was that about a year and a half into the KTP…

I: Yeah I'd say I was in marketing for about a year and a half, but when he came in he'd seen industrial design previously and felt that it should be located within engineering.

JG: How about your KPIs, were you assessed on things similar to marketing in the beginning, was there a shift in what they expected from you?

I: No I wouldn't say so, to be honest, there weren't any KPIs at the start because I wasn't working within Organisation A so I wasn't inside the system and because I was just developing the role they thought that I was still finding my feet a bit. When I've developed the KPIs more recently, when I joined the company, it wasn't really swayed by either marketing or engineering, it was kind of from its own merit. One example of a KPI that I did put in that would actually allow me to work with marketing more is that I wanted to be customer facing with at least one major customer for each project and that's part of my PPP and KPI to make sure that I'm seeing someone on each project because I'm meant to be customer facing and there's been some projects where you're just developing in the dark with the team. So I think that's the only thing that's swayed it from a marketing side really.

JG: So did you just set your own KPIs when you were coming up with the role from there?

I: Yeah, I worked with another guy as well, one of the engineers.

JG: If a new innovation project was to be kicked off from within the organisation, how would that be initiated?

I: That would be something between, well it would definitely be marketing-led but I think I would be one of the ground stones behind that. I think I'd be one of the ones that led the innovation behind that or at least gathered the team together. But it'd be the marketing manager that would have to give the go ahead and say that we could allocate resource for it. So it'd be between myself and marketing but only because they give me my resource anyways. The way that I map my resource at the moment is 50% projects that are already in the project winnovation or live projects and then 50% is personally allocated to the marketing things so forward thinking. So I'd kind of swing that towards one of them projects.

JG: Thinking about the company again, are there any key capabilities that design has within Organisation A?

I: Yeah, I created a presentation before which shared capabilities that I'm bringing into the company. First of all its the freehand sketching, I always thought that I was good at sketching anyways at uni, more so than CAD so I pushed that more when I joined the company. Basically playing to my strengths, particularly because our engineering team are pretty good at CAD anyways. So they all work in inventor and although I can do the basics it seems more appropriate for me to work on my sketch abilities rather than CAD. So that's one thing. I also try to take other peoples ideas in brainstorms and pin them together so I'll be the one to show that concept. So there's that kind of capability, being able to draw ideas clearly and present them in the right way. Visual rendering as well, we use showcase, that's something new to the company, to have that in house. Facilitating brainstorms in a creative way as well, using approaches endorsed by the likes of IDEO. Although I'm trying to get engineers to adopt the approach its still something that hasn't been done effectively until design comes in. And as well kind of an eye for visual design, for aesthetics. I try not to focus on aesthetics too much because they'll say its just all about how it looks but that's a key aspect about it and looking at the brand as well. We have a really good team for looking at the branding aspects of it, looking at things like brochures and websites but when it comes down to branding on the designs most of our engineers have worked here since before Organisation A even took over so they aren't really familiar with the brand or have an attachment to it and when they are designing they aren't thinking about the brand. The only thing that they'd think of is maybe painting one of the parts gold. I'm trying now, although these projects are slow and they might take a while, I'm trying to look from the very start to make sure that all of the projects going on have a familiar family look and feel and setting that as a direction. So that's another capability that I'm bringing in. Another thing that I'm trying to bring in as well is to amalgamate some of the different knowledge between divisions because we work solely within out division. Although Organisation A is a corporate company and has other divisions that specialise within filtration we seem to just work within a silo and it always has been that way because our division is set on its own metrics, it has to make so much a year so its not focused on what others are doing. I've done some work overseas and worked closely with other divisions, I've actually worked on various projects with our partner divisions and trying to go down the route of having our division as a centre for industrial design. Then we could bring other divisions in and brainstorm and come up with new concepts together.

JG: From your experience, do the other divisions operate quite similarly to yourselves?

I: Yes and no, some of them will say that the don't but its fair to say everyone works for its own metrics anyways. But its trying to change that mindset because its quite hard to convince another division to put a couple of their engineers on a project for us for example as they might not see as much profit as they would otherwise. Then you have the politics between the European divisions and the North American divisions as well, if

we come to localise it here and we're developing something for them we'll make quite a lot more profit than them so its quite difficult. I have been over to America to show them a bit about industrial design and there was a project in particular where I went out with the team to visit a customer and I couldn't work on that project at the time as I was working on something else for my own division. But we went and visited a customer for them and tried to ask a few different customer-centric questions that weren't getting asked by the engineers and the marketing team. So why do things have to be like this, or how would a customer access this or why is there so many fixings, is it going to be wall mounted. These kind of things weren't getting asked by engineers, what's the noise levels got to be on this. These questions did actually get used on the final project although I wasn't actually there doing it. And you could see it in the final thing, that they'd taken on board the answers to these questions. You could even see it in the way that it was presented, I'd shown them some of the work that I'd presented in the past and I'd used sketches. So for this, they still used renders but they used things like little hand written notes on the final thing, so you could see that I'd had a bit of an impact in showing them previous work.

JG: So were they not using design at all previously? In the way that you are using it?

I: No one in the filtration platforms certainly, they don't use design in the same way. They don't employ industrial designers specifically but I think that there will be some engineers in some divisions that probably think like that naturally and probably could work like that. So what I'm trying to do is eventually source out the people from other divisions that do think like that. They don't have to be industrial designers but they need to be capable of thinking like that and they want to think like that. Once that process has started we can work on future projects together. Its hard because it needs to be endorsed at a corporate level for things like that to happen, but within filtration I've kind of gotten the point across to some of the right people and they are getting it but its just about timing really.

JG: So how was the KTP initiated, if it wasn't from higher up, was it a middle management kind of thing?

I: It wasn't from a corporate level, it was at a divisional level. It was actually our marketing manager. We've got quite a big marketing team, around eight people in total including product managers and then we've got the marketing development manager who was the one that got the University involved in the first place. It was for one particular project which was a nitrogen generator which was launched just before the KTP started. It was him who worked with the University because he knew someone there from previous work. And then from that concepts were developed went into the final product and as an afterthought of that the KTP came about. Just going back a bit, before the project started all of the products were red and associated with the original Dominic Hunter brand, then this new product was branded as Organisation A going forward. So the University were brought in to look at the aesthetics of Organisation A and branding and were asked to incorporate that into a new design. Most of the major design decisions had been made on the generator so it was a case of what changes can they make aesthetically. So that was done and then that product was launched and they wanted to go and look at the other current products and see if they could be brought into alignment with the new branding. So a piece of work was done to bring about a family look and feel in Organisation A colours. So they were the two projects that they had with the Uni and then from that it was agreed that it would be best to have industrial design in house rather then just having it outsourced from the University, then in that case design could get involved more at the front end of projects, which was when the KTP was developed. So it stemmed from a couple of projects with the Uni.

JG: Did you have a particular brief when you started or was it just to continue the work that was done previously?

I: Yeah, I had a project plan set in place for the KTP which was numbered, there was about nine or ten different stages and a Gantt chart at the end which said how each section would be split up throughout the duration of the project. It took around three or four months to even get my head around what my purpose was and what I was meant to achieve. Really I just wanted to get on with designing, it seemed like quite a difficult challenge to embed design within the company and what I really wanted to do was to work on projects. On this project plan, there was something in there that had already been discussed with Mark about being the initial testing project for industrial design. So within this project, the whole project was to embed industrial design, so within that I had to create different processes and toolkits and things like that. But to actually test them, there was one project in particular which was surrounding soft drinks dispense. We weren't actually sure whether we'd go down that route initially because when the project was written we weren't sure if it was an appropriate marker and the company were a little bit unsure as to whether it was a suitable launch project for me to test industrial design. But we tried it out on some customers, and that project was around filtration in soft drinks dispense so behind bars and restaurants. We already had a product that was used in the Coca-Cola factory in their bottling plans so now we wanted to create something that made that smaller and made it face to face so you could house it in a bar or restaurant and that seemed completely appropriate for industrial design because unlike our normal work which sits in quite industrial environments, this is going to be sat in the back house of a public place, used potentially by people who work in McDonalds or whatever and have no experience of working with industrial products therefore it would be totally unnecessary to use an industrial filter in this setting. So that was the project that surrounded industrial design and lasted around six months, which involved a lot of visiting customers. But there was various smaller projects as well in that for me to test out.

JG: At the start of the KPT did you have a sense of what the organisation wanted from you in terms of value?

I: At the very start, I think that Mark did more than I did really. Even when I started I kind of thought what can I do in this. Its already very technology focused, its very industrial. I had only just left uni and my type of products were teaching products and things like that so this seemed completely out of my realm. So I saw industrial design kind of like what engineering did as looking at the aesthetics of the organisation and the branding so changing the look and feel of the products. I didn't really think that there was much I could do in terms of work and how they used products because it seemed daunting to understand these products and how they worked. So that was how I felt initially and that probably lasted six months or so. I think working closely with the guys at the uni and them giving me their perspective on things helped me, obviously they wrote the brief for the project so there was regular meetings and I wasn't just left to my own accord. I think they helped me believe in myself a little bit and about industrial design being a lot more than something that just makes the products look a little bit better. It has actually changed now because I see it more that way and so does everyone else in the company, something that can be used at the start. But I think it probably took around six months before I understood the role that industrial design could play here.

JG: Do you get a sense of how valuable people perceive the work to be? Obviously they've hired you and you've continued your work so from that perspective you could class it as a success but have people said anything explicitly about that?

I: Yeah I mean it gets brought up showing other divisions what we are doing and how we are looking forward, we'll show them that we're using industrial design and how its helping us to move forward and understand our customers more. People at a corporate level can see the value of industrial design as well because they've seen some of the work that's been going on. They are more connected with the marketing team and the marketing team have been using industrial design with our customers. So we've had customers come in asking for a basic filter to replace their current filter and I've actually

worked with these guys to create something completely new and out of the box. So that relationship has then opened up doors to completely new projects and that's estimated in millions in terms of potential value. The marketing team are then presenting this out at a corporate level and its getting recognised, I think its a bit lame but they call it their secret weapon sometimes because other companies within the division aren't using industrial design at all.

JG: So before you arrived, if a company had approached you and asked for a certain kind of filter, would the process have just been the marketers handing that off to engineers and saying ok we want this and then they would have acted on that as opposed to taking a customer focused approach?

I: Yeah absolutely, the way it had worked, and actually the structure of the company has changed slightly, but we had BDM's which were basically sales guys and they would act as the voice of the customer which was actually completely backwards. They would go out and then that's what they would bring back to marketing, they'd say that the customer has asked for this or that and want something to perform at this level etc and they need it by May next year. Then based on the value of the project, it'd be fit into the work stream from there and that's how it worked, they'd purely go from the specification and no one would question it, or they might but they'd get on with things anyways. But what they found is that things would be completely wrong in a number of cases, things would be too high a specification or over budget because from a sales point of view, they want to design something for everyone. They'll visit customers independently and agree to everything that they want without really asking design-led questions. They'd just ask yes or no questions. Whereas what I'm doing is trying to ask better questions and I'm not trying to design for everyone because that doesn't makes sense. So now, marketing will find something and come to me saying that we've got a big customer on board now, this is what they do and this is what they've asked for, but can we do something else. That's the kind of thing that will open doors for future projects and make more money in the long run for the company. So now, it starts from marketing going to the customer but when it comes to what they want from a product it'd be me who leads them conversations.

JG: You've mentioned a few things already, but are there any barriers that you haven't talked about in relation to the work that you've been doing? They can be things that you've faced in the past and have managed to overcome or they can be things that you are still faced with now.

I: Yeah I think I've covered the main ones. I mean, it might not be much but there's things like software issues. The company let you do any training that you want but because of our IT structure it took me a while to get rendering software and things like that. I don't think I'm having barriers as much anymore as the structure of the company has changed a bit but that was something that I hated. Because I'd do renders and they'd look like they'd been done in 1999 or something like that. Actually, not any more, but getting out in front of customers was a big barrier. When they had BDM, sales guys, in probably the first year of me working here I couldn't actually go and visit a customer without them being present. I don't know why but I couldn't just turn around to Coca-Cola and say I've got an idea for a project, they'd turn around and say that they had to talk to them first so it was a really slow process to get in front of them. Partly I think it was because I was new to the company and they thought that their relationship with clients might be jeopardised in some form so that was a really big barrier, getting to people that we wanted.

JG: Did that change when the marketing manager came in?

I: No the marketing manager was already in then but his role was different. What happened was that the BDMs had their manager and they were customer focused but shortly after that they were made redundant. Its not nice but that team left and then it allowed marketing to focus on the customer research and lead that. Which was a lot better as there was a much better rapport with marketing as they didn't have their own

accounts or anything like that. They also worked with me already so they knew and trusted industrial design by that point. So if I said that I wanted to visit a customer and I've got an idea for something they'd be a lot more open to it, they'd encourage it. So that barrier isn't present any more. There's little barriers that kind of effect everyone such as budgets, money is always going to be a barrier. Two recent ones I can think of, there's been a travel ban internationally since October to the end of the year in order to save money. So with marketing being customer focused it stops you from going to see some of the customers that you'd want to visit abroad. There's also a case in which I managed to get a 3D printer which I had to fight for for a while so we now have in house 3D printing capabilities. Its only a 3 grand piece of kit but I had to really strongly build up a case for the company to spend that and I think the case was good enough in order for us to get it in but that could have been a barrier if they didn't allow us to get it in because it was a poor month performance wise for example.

JG: Who do you need to make a case for with things like that?

I: The engineering manager. So R&D have their own manager, product development which is another aspect of engineering have a manager and then industrial design is another aspect. Then they'll all report to the top engineering manager and that's how the structure works.

JG: Do you work with any other functions outside of the people that we've mentioned so far.

I: No, marketing, R&D and engineering are the main ones.

JG: Are there any main knowledge gaps that you feel are still present? Either for yourself or other people in terms of implementing design-led innovation?

I: Its hard to say, I mean I think the biggest knowledge gap was me. Thinking about design-led innovation. We were doing aspects of that when I was at uni but I wasn't doing a lot of the theoretical side of things, it wasn't until I started my masters that I started to build my knowledge and learn what other people are doing. Looking at people like IDEO really helped as I didn't understand what they were necessary doing at undergraduate level, whereas my understanding is a lot better now. I think what would be good potentially is user experience design. That would work well. I think there'd be difficulties in building it up but it'd be really effective. I was asked to do some of that but I don't feel like my strengths lie there even though I'm user focused. I think someone who is more focused in that area would work really well as they could look at things like packaging design. We aren't really known for the best services or on time delivery and things like that so that would really help.

JG: Does design play any role in setting organisational objectives?

I: I wouldn't say so. I've had a little bit of advice from my own initiatives so suggesting who I'd rather report to and things like that. But I wouldn't say there's much above me that design would have an impact on.

JG: The design processes that you're using, I know you're looking at toolkits and things at the moment, does this mean that you are still trying to work out exactly what design can be for Organisation A?

I: I think I've still got a lot to learn, I'm developing my own toolkits anyways. They already have their own processes in place which is called winnovation and that is a project from start to finish. Within that they map the processes of marketing and engineering but I initially saw that as risk management as its about funnelling ideas through. Over time I've created my own map that associates with this plan so I've put my own activities in and mapped out the people that are responsible for certain things. Most of the time its me but I'll map out who I'd need support from. So for example if I'm visiting a customer then I'd need support from marketing or maybe they'd lead it. I've

also mapped out the current engineering activities and put where industrial design should be supporting them on their activities. So that's the effect that I've had and its taken quite a while to develop that.

JG: Ok so lastly, you've mentioned trust in terms of increasing your influence. Could you comment on how that developed over the KTP?

I: It was a natural progression really, I don't think there was a cut off point. I've tried to involve as many people as I can in the process and show them what I've been doing rather than just getting on with it. So every now and then I'll do a presentation to the team and show them what I've been working on giving them an update. Also we did like a change loop exercise which was ran by our engineering manager which was about creating the industrial design role so how are we going to get people to believe in in. So that involved presentations to the marketing and engineering teams with a Q&A session at the end of it so that people could ask about industrial design and I think that helped a lot.

JG: Do you think that people's awareness of design in terms of creating business value changed parallel to that?

I: Yes and no. I think that a lot of people from engineering have the same struggle as me where its hard to get an idea out there or make a difference when you're facing so many barriers. So until the day comes where I've pushed something completely game changing through winnovation without being turned down along the way by the powers that be. Until that day comes I don't think people will believe in it completely. I think people like marketing are fully aware because we're buying in new customers using industrial design but because the engineering team aren't necessarily customer focused they aren't maybe seeing the value but I think they are seeing the positive rapport in the office and enjoy being innovative seeing ideas in sketched concepts. Its also maybe worth mentioning that I've been placed in various parts of the company too so marketing and engineering and I think that's helped loads in terms of building trust particularly with engineers because they were the first people that I were talking to within the organisation.

JG: Slight side question on that but do you ever face any supply chain issues?

I: Yeah I have although they've been quite minor. Because I work in concept development my main point of contact is engineers and I know they have issues with supply chain. So I think if I get to the point that I'm working to the end of a project in the future it could be difficult. However, production have been really helpful in helping me understand manufacturing processes.

Organisation B: Penny

JG: To get started then, what is your job title within Organisation B and how long have you held that role?

P: My official title in Organisation B is packaging designer and I started last November so its been a year almost.

JG: Ok, as part of that role, what are your key responsibilities within the organisation?

P: I would say that mine is more of a support role because I can use several different softwares so when there is something to do, usually I find the right tool to do that. Moreover, I think my role is packaging designer but I think its more from a strategic perspective because I'm working quite a lot on experience mapping and circular economy as well. But at the moment I'm working on experience maps and how we can connect design with all the departments within Organisation B. Using design as a connector basically. At the moment I'm developing quite many new tools that we are trying to validate within some projects, so basically its about connecting the dots, seeing when we can apply a particular tool using experience maps or customer journey as well as design language, brand books all integrated together. Its not easy though because its very new stuff and some people don't quite get the value unless you provide or unless you do it yourself and they see the results and think oh wow this is amazing and want to be part of that.

JG: I'll probably come back to this later, but when you say that some people don't get the value, are you working with different disciplines within Organisation B?

P: Not directly, because I'm not a project leader. So I work in a support role. What I do is connect with another person inside my team who is a project leader and he usually passes me data about other departments. Then I try to connect what they are able to do and how to use that data in the most efficient way.

JG: Thinking back to when you started at Organisation B, did you receive any specific design focused training?

P: Not really, the only training I did was about CAD but to be honest I haven't used it that much. No particular training on design thinking. I mean there are some topics, quite hot topics at the moment but there's no training. I'd just say its a community.

JG: So its just a case of picking things up along the way?

P: Right, so there's some stuff to read or stuff to see as an example, its more like a community than proper training. But things are evolving nowadays, I think that in the next future we will have something more closer to proper training.

JG: I take it you received more general training, not design focused but generally integrating you into the organisation

P: Yeah, there are plenty of trainings. Most of them are not available to me because I'm a contractor, its not a permanent role. For instance some trainings regarding design leadership are not available to me, where some other trainings are available and I can do them. Like trainings on circular economy or even external trainings that are available online. So usually someone picks up a link from the web and says this could be interesting, why not give it a try.

JG: So thinking more broadly about design within Organisation B, can you describe the role that design plays within your processes and maybe if it does more than one specific role can you talk about how they maybe connect?

P: I think design within Organisation B is more about balancing what the brand team wants to achieve and the business as well. So its not the proper design world that one could expect because its more about trying to find the correct match between these two categories. So I would say value for consumer, business value and brand. This is the connection where I think design plays a role within Organisation B.

JG: Are they the two main teams that you work with as a discipline?

P: We work a lot with brand teams but as I said I don't work directly with them. What I do sometimes is participate in a workshop and help with organising the workshop so doing some mock ups and things like that. And in the workshop usually there are people from all departments so people from CTI, CMI and all the departments. So yeah, I work with other teams but not directly, because I'm not a project leader. I can tag along sometimes if I need some information directly but its not vital I would say.

JG: So thinking broadly about Organisation B's innovation processes, how much is design involved? Does it play a large part or is it more of a supportive function.

P: It depends on the kind of innovation to me, because sometimes it does, like the workshop we had in Italy about circular economy. I think that was a great opportunity for design and business to find a new landscape, but sometimes people don't get the value. So for me the role of design in innovation is to let these people understand that there is a value and even if the path is really challenging, the role of design is to let these people understand what is behind the risk of taking such approach. So that's regarding circular economy. Sometimes what people say is just people don't have the right mindset to pick what you're saying. So there's a big constraint surrounding business and the, you know, business as usual kind of thing. We do this and we've done this for a lot of time and don't see why we have to change now, it could be a risk, it could be this or that. So the role of design is to let these people understand that but its not easy at all because you have a lot of constraints.

JG: One of my later questions is going to dig into that a little bit more actually so I'll come back to constraints later. More broadly again, how supportive is the organisation of design within your innovation processes?

P: I think the support its really good, we receive a lot of stimuli from the organisation directly so I think that's not a problem. The problem is connecting what we are trying to achieve as innovation and put it in place. I think the Italy workshop is a bright example of that. We aimed to do a lot of things and now they are struggling to find the wave 2 of the project. So I think when you receive a lot of stimuli, the problem is how we can translate that stimuli into something that is actionable. Because another problem is the short term, because every time we have to put in place an innovation that has to be good for consumer, brand and for business in a very short time and the problem is we don't see that as opportunity or as an investment. We see that as a challenge or as something risky. I think that's a huge problem because as I said we have the right mindset but somehow we've missed something in between we want to do that and how are we going to do it.

JG: You've mentioned risk there, what's the overall viewpoint towards risk. As a design team are you encouraged to take risks in your work or is it more restrained from that?

P: As part of the design team, part of our role is to analyse how the world is changing or is going to change in the next years. So if we take that as an example of how the new products could be in the future, if we say for instance that materials and water

scarcity will be constant for the next twenty years, we already have a clear panorama of possible products or new services or approaches that we could put in place. The problem is that the changing is time demanding, its money demanding and we always find someone that would say no its not possible now because there's no budget or its not possible because we have to many projects in place. In particular for circular economy, its a huge pity because we have a great opportunity, not just for this project, but for everywhere, every brand really. We have a lot of brands and use a lot of bottles so we don't have the right attitude, the right mindset. We don't have the pioneering mindset that is necessary to have that kind of shift.

JG: Do you think that mindset is one of the bigger barriers that you face as a designer operating within a design team within that sort of environment?

P: Yes, because… I see the point that business people… I see their point that they have a mindset really different from ours so they understand things that we don't. So I see their point, so they could say we don't have budget and I'd agree with that. I can't say anything because I don't know about that, the entity of our budget, its not really what I can know at the moment. But if you think about the word design its just about putting into place something that is valuable and possible but if you don't give the opportunity to design to express that value, to unlock that value. If you say no because we don't have budget or don't have that, with an infinite amount of money everything gets easy right? But the role of design is to connect the elements that we have and to find the best possible outcome. So that is one of the things that is not understood, that design could unlock that with very little resources. But if they don't say to us, yeah start doing it, then we can't really do it. We can just sit and try to convince other people. Things are changing but very very slowly.

JG: Do you have any strategies that are emerging as a positive way of bringing about that change? Is there anything that you've done that's worked really well?

P: About circular economy you mean?

JG: Just generally

P: Innovation?

JG: Yeah

P: There is a strategy in place about innovation which is part of the 2020 strategy, but its more about design for experience. How we can unlock the best experience using the data that we have, so that's fascinating but as I said we don't lack any stimulus, we have a lot of stimuli so its not that [that's the problem]. I think its more of a broader problem that as a multinational, as a big company, we are struggling with agility. So we are worldwide, present in many countries, we have our supply chain we have our business as usual kind of way to do things, so what is missing is the agility, how we can shift in the kind of more profitable way the innovation. Everything takes place very slowly, I don't know why to be honest. I think its because there are a lot of people from a lot of different categories with a lot of completely different mindsets having a clear understanding of the word innovation, just what innovation is, is already extremely challenging. So possibly we should have like, kind of bright example to follow. And we have got some, but somehow… I don't know how but we are almost ready to say yeah that's a wonderful job but when its time to put your hands on something new its extremely challenging to let people understand the value behind that.

JG: You mentioned that you have some bright examples to follow internally there, can you maybe talk about one of those in more detail?

P: Yeah, for instance last week I participated in a workshop regarding 3D printing creativity session. So it was about how we can 3D print chemicals to develop new products and it was really, I think its a great innovation but what I regret about that is

that I participated in the workshop and it was all about chemistry. Like how we can put that onto for instance a kind of surface that could have been like a glove or something and how we can deliver that. No one once talked about consumer journey or value for consumer experience. To me that's an opportunity that's lacking because we have a new technology that allows us to print something so we can customise our products a little bit more. We can even do something more specific, we could do something that is basically new so what I would have done in that workshop would have been to analyse the consumer journey, the design for experience, the value for consumer and maybe taking look also at circular economy because the product could be the packaging or the packaging could be the product and you could be printing your own stuff but no one cared about that. I stayed quite silent because I don't really get chemistry at all…

JG: Was that a workshop that was organised by scientists?

P: It was organised by a guy from discovery. Now after the workshop, it wasn't really a workshop to be honest, it was more of a discussion or round table. There were no post its or sticky notes, nothing. Just a presentation and then a round table discussion. But it was all about chemistry and how we can solve chemistry problems like how we can attach things to a particular surface and how we can do this and that but the beauty of 3D printing is that we can bring together different kinds of chemicals, you can have different releasing times and all these kind of things. So there is a value but I think we have to connect that value to the customer one and to the business one to have a sort of comprehensive map of every possible outcome but that didn't happen. After the workshop I tried to speak to this guy and when I mentioned circular economy and design for experience he was like a little bit out of the blue, like asking why you are saying that when we have already found a solution. So I don't know why but when I have a problem and I have 10 days to solve it I normally spend 9 days thinking about it. The workshop was like ok we have 10 days, in the first day we find a solution and then the other 9 days we develop it. And to me that's wrong because if you are basing that design on a wrong assumption then you have wasted 9 days of work. You know what I mean? But its not easy because when you try to talk to these people they don't really get it unless you provide an example but even in that case they are like you know we want to have speed to market and have to do things in the quickest way possible and then you say ok.

JG: What was the breakdown of people in the workshop then, were you one of the only designers there?

P: Yes, I was the only one designer there related to design for experience and circular economy. I was the only one.

JG: And was it a mixture of scientists and marketing for the rest of the people?

P: Yeah, scientists, lab guys, yeah pretty much

JG: Since you started at Organisation B, do you think that design's influence has changed at all? Have you seen any development there or is it quite similar?

P: No, I have seen some changes but its something that is taking place little by little. A little because I am working to bring a little bit of innovation in design for experience for instance. So for one project, me and my colleague, we have done pretty cool work for design for experience that has been taken as an example to how to deliver a total brand experience to the consumer. So I think things are changing little by little providing the right stimulus. I'm saying that because I'm working on that when I have a little bit of spare time, trying to innovate the way that we design for experience. So trying to validate the tools that I'm using and trying to use them in projects. So its a sort of strategy kind of role, which is kind of a new role and I'm trying to affirm it. So lets see how that goes but I think that the mind is ready for this, we just have to find the right project to put these tools in place and see where we go.

JG: My next question is about as a design function, what disciplines do you work closest to and how?

P: Hmm the closest one. When you say discipline, you mean inside Organisation B or in general?

JG: Inside Organisation B, so departments that you work closely with

P: So as I said, I am not a project leader so I work more within my team so I receive inputs from my project leader and he talks more with CMI, CTI, brand teams. So he has more connections than me I would say. What I do is try to translate those into something that we may use as part of our projects.

JG: Ok so say if one of those teams gives you some work through your project leader, would you then have discussions with that team or would you be more isolated?

P: Both, it depends on the situation. When we rush I'm a little bit isolated but I receive feedback from my project leader. Some other times I am involved in the discussions and I can just say what I think directly to the other teams.

JG: Can you maybe talk about an example of when you've done that and had that level of discussion and things have gone really well?

P: Ok yeah so we have done a project where I had done a piece of work, an experience map, for a project inside of Organisation B and I added some layers in that experience map which were unknown until I put them in place. Everyone was really enthusiastic about that and what I did from that point was to try and develop it to the next level. But to do that I had to take some input from CTI and CMI so what I did was try to convince my project leader that we had to connect our role to the others because if we use an experience map which is fed not just by a designer's assumptions but also with data from CMI and CTI then that would be extremely more powerful than a normal experience map done by a designer based on his or her assumptions only. So that could be a connector, create a really strong connection between us and the other teams inside Organisation B. So I did it and somehow we managed to have a discussion with CTI and they took, we wanted them to take responsibility for some parts of the experience map, because what they did was, since this experience map was done for a project they wanted to be credited. Even if I did all of the work they wanted to be involved with that they wanted that credit pretty much. So after that I wanted to point out that they have to take responsibility for parts of the map, otherwise its not collaboration its just you saying stuff and I'm doing that. So we had a discussion with them and they agreed on that and they really liked how we evolved the role. Because somehow with CTI its always that they think we do some sort of magic kind of things and they say we don't like you because we don't understand what you're doing but its correct, we just don't know how you do it. That's design magic I'd say but you can't do that, so what we try to do is involve them and use what information they have into our experience and its still in development but I think we've done the right thing here trying to involve them. And we had a discussion and they were really pleased to help, really pleased to understand how an experience map works and how they can feed data, so now we have a roadmap or strategy in place how they can help us developing a new level of experience map. So that discussion was really helpful. But as I said, we had to bring a bright example, a very strong one otherwise they wouldn't understand it. You know what I mean?

JG: Yeah, just for clarification what does CTI and CMI stand for?

P: CTI is customer technical insight and CMI is customer marketing insight

JG: and is the collaboration that you've mentioned common amongst other disciplines that you've mentioned within Organisation B?

P: Its common but not in experience mapping, not regarding design for experience. But there is of course a collaboration because they provide important data that we want to use in order to have the right persona.

JG: Right but I guess its not as collaborative as it could be?

P: No, in my opinion our example is better because I think experience mapping is a very under rated tool. I think its brilliant. Its so powerful because we can shape it as we want. We can continue adding layers on the basis of what you are trying to achieve. Its this thing that people don't understand. Its a wide world, like they say about design, it takes so many colours and its quite under rated. So this collaboration between design and CMI or design and CTI is going to be extremely powerful, that's what I hope for.

JG: So that project's ongoing, do you have a sense of how they have perceived the output? From what you've said so far it seems quite positive. Have they specifically said anything about that?

P: No not yet, because we are still waiting for the kick off of the project because what we did was the other project we didn't involve them too much. The previous project was more like an example to bring to them. Now we are waiting to put this strategy in place for the next project but we are still waiting for the official kick off.

JG: Ok, in terms of the capabilities of Organisation B from a design standpoint, do you think there are any capabilities that you feel capable of describing?

P: What do you mean by capabilities?

JG: Capabilities being generally the set of skills that the organisation has in leveraging design

P: No they don't have any strong capabilities at the moment. Experience mapping is something that has already been used here for several years but we are innovating it at the moment in a way that no one did before.

JG: My next two questions are related to that then, are there any knowledge or process gaps that you think are needed fill before Organisation B gets to that point?

P: From my side or Organisation B's side?

JG: Maybe both

P: Well from my side it would be better to have a more clear understanding of the whole business and how it works. Because even nowadays I'm here within Organisation B and some parts of the business are still a mystery to me. From Organisation B's perspective, I think that one huge gap is that people don't understand user experience map at all. If you give them a very polished experience map, very graphical, very visual and point you out that these are the areas of interest we could focus to find the right solutions for this particular problem or a new way of using things because we think that there is a potential, then they don't get it. You have to set a set of conclusions and say this has to be done this way, this has to respond to this needs and so on and so on. So if later you give a sort of design brief in excel kind of format then they will understand that. That's a gap, they don't get the visual things they want to read what you are saying.

JG: That's very interesting, do you think that they understand the processes involved in you work?

P: No, they don't understand the process for the simple fact that, for example CTI wanted to be involved in the process because as soon as you draw the trend on an experience map, you go a bit higher and they say how have you done that, what kind of data have you put on there to have that trend actually and not another one. They don't really trust, I think its the fact that they don't really trust your design assumptions. That's why I wanted to connect with them, so they now have the responsibility for the design experience trends. So they provide data with how the consumer reacts to particular technical kind of things and we as a design team deal with the other part and write more personal user experience.

JG: So with that project being ongoing, did the CTI team feel more empowered by taking part?

P: Yeah they feel very empowered by that, they feel happy to participate and I think that at one point they would like to take it on. This is my thinking, because no one wants to participate in the first place but when a project is promising, its bright and they say this is really bad-ass and after a while everyone wants to jump in it. But to me its ok, its a pleasure because it means that the work I'm doing is valuable.

JG: Do you see that as validation for your own methods, kind of building up your credibility?

P: Yes, the problem is then that some of these tools that I'm developing are so innovative or cutting edge that even my team struggles a bit to use them because, and that's a shame because I think that those tools are valuable. But because I'm not a project leader I can't really say I want to use this, lets give it a try. So what I try to do is validate in a different manner. I try to take existing brands and see if the thing that I'm doing actually match with that particular brand. So if I can prove that, what I've done so far then its working. But sometimes, because there are too many people involved in a project, I can't really jump on it and say I want to do this. Because maybe the project is in a different phase or maybe people don't know you, they think that the thing you are doing is not valuable enough. Even when you know that they thing you are bringing is bringing something more on the project.

JG: Ok excellent, so we're onto the last batch of questions now. These ones are looking more at the workshop that we did in Italy. So to start this section, in your own words can you describe the purpose of that workshop?

P: To me, the purpose was to see if the project would have been suitable for a circular economy approach and how Organisation B as a sustainable company would tackle that and how circular economy opportunity for the project could have been treated in the most profitable way. That was the aim of the workshop in Italy for me, especially in wave two. We had quite a lot of time to think about how we could set in place a service or a product in line with circular economy and in line with value for consumers. That to me was the aim.

JG: Alongside that, as a brief were there any particular rules that you were given either explicitly or implicitly? Were you told that you couldn't do any certain things?

P: Well, honestly, no. Because what the Italy team told to my team was that you have a blank sheet of paper about circular economy. You can do whatever you want as long as its circular. This was one of the first things that they said to us. Me and my manager watched, we were a little bit like, are you sure about that because circular economy is not an easy topic. If you leave us with that wide open mindset then its going to be something that's maybe not in line with the business or not what you want to achieve. So my feeling is that even the team in Italy didn't quite know what circular economy was and how we can trigger that. Because if they had previous ideas of circular economy they wouldn't have said that you can do whatever you want, because circular economy is really challenging. Its not something that you can put in place in two years

or something. I don't know but I had the feeling that some people didn't really realise the scope of the thing. I didn't have any particular rules to follow but I was conscious when I was presenting my video that people didn't get it at all. That's why I was so scared about having the circular economy topic wide open, I was quite freely in that topic because we could put in place a service for instance instead of a product but how could you tell that to people in Italy that we are going to put in place a service instead of a product. That's crazy for them. They don't get it, even if you try to explain it. And that's a little bit frustrating because there is an opportunity there but to me its not yet discovered. That's my opinion.

JG: I take it that the work is still carrying on since the workshop? Has there been any further involvement from you?

P: Haha no, but not just me even my team. We are still waiting for like sort of a road map to follow. But we are doing that on purpose. The Italy team is leading the project right, so we want them to kind of highlight the next steps to take. We don't want to say that the output of the workshop was this and we want to do this and this. No, they are leading the project and the workshop so my manager is right when she says that they have to tell us what they want to do in the next steps. And we as a design team will do our best to achieve that. And that's why we are waiting so long, because in my opinion they don't know what to do now.

JG: Is there anything that they have taken forward?

P: No not yet, probably we will catch up in the next weeks but as I said my opinion is that there were possibilities and the assumption that the aim was really high and we just didn't get it. We just stand for another option that it may be usable but its not as high in the value as the first thing that we wanted to do which was circular economy at its finest.

JG: From an internal point of view, do you know how that project came about?

P: That was a spin off of project Grasshopper which was basically a project related to reducing some of the pack to achieve a certain percentage of plastic away from every single pack, now I don't really remember but it was about reduction in order to increase the size of profits. So it was a spin off and maybe someone at some point at one point said you know we can trigger circular economy and maximise even more the profit. So that to me is it, and as I said its completely fine if they've changed their minds and don't want to focus on circular economy as a suitable thing to do now. That's ok. I'm a little bit disappointed because the first aim was really high in value and we just, we are satisfied now with something that is not really satisfying for us. Its completely understandable because business works like that, you have to be able to take the right decision at that specific point. But to me circular economy is a really huge opportunity to Organisation B, but not just for this project, I'm talking widely in saying its a huge opportunity for Organisation B since we have a lot of brands and if we set in place a circular economy approach or production line, not for everything but maybe starting with what we can, so certain projects only then we can turn every single brand into circular in the next years. I don't know how many but we could do that and become a bright example, which is in line with circular economy, which is one of the hottest topics nowadays about sustainability. So that could be a real opportunity for us to affirm our principles and even be a great opportunity for publicity. People would talk about us, because its a multinational, that word sometimes comes with meanings like pollution and plastic and that kind of stuff. Yeah its true but we could be aligned with circular economy doing something that nobody did before. But that's the design dream.

JG: How would you describe your role within the workshop?

P: My role to me was a provocative role, that's why I had that video in which I showed examples that didn't take in consideration the product at all. I didn't touch the bottle at all in the video, the bottle remained the same if you watched it, completely the same.

That's why it was provocative, because I wanted to show to the audience that other ways are possible, not just changing the product. We can do something even more provocative, not just pack, we know we are a pack company ok but we can do something more. Its not just that. So I wanted to provoke the conversation in that way but I was quite surprised that nobody said a thing, that was a clear sign to me that the mindset was not the right one for a circular economy approach. Maybe I'm a little too strict in this but that's the sensation I had. Because when I talk about circular economy in my team its completely different. We are innovators, pioneers, whatever you want but at least we understand the value of that. We're quite ready to try and find something that is valuable for the business where other people from other departments that work just with numbers, they don't get it, they don't see the point of it. Because they don't realise that the world is changing and its changing so fast. So if we put in place now a small strategy, we don't have to change in one week all of the supply chain and all of our production line, even in a month. Even having a small kind of strategy set for circular economy and develop it step by step, baby steps, you are ready for tomorrow. Because the worst scenario would be that someone would develop a circular economy approach and we buy it, because that's what Organisation B does a lot of times. We just buy other companies. But its silly because you can put it in place. The actual worst scenario would be that a competitor puts it in place before us, that would be a great risk because you can't buy that and as I said the world is changing, resources and materials are lacking so the more we prepare for that in advance, the better it is. and we are not prepared for that, we are just talking about it and that's the problem.

JG: My next question, and I could be wrong here, but on the day of the workshop, it didn't seem like there were a lot of designers there compared to people from different backgrounds.

P: Yeah, there weren't so many designers there, that is true

JG: Was there a reason for that?

P: I don't know to be honest, I don't know yet. To me the thing is that there were, to me the problem was the mindset. If I had to find a problem for that workshop it was the mindset of certain people that don't see the value in that. They do it just for the sake of doing it, with the same principles that they'd use within a standard project. When trying to develop a circular economy you cannot do the things that you do with every other project, so reducing plastic and things its not about that. You have to tackle the project from another perspective, its not just that to me. Because there were too many people involved in too specific departments with not the right mindset. But maybe I'm too strict in this, I repeat. To me the right mindset was missing there. I understand the business problem but then why have a workshop in circular economy then, lets just continue the business as usual approach, its like having a stone to throw but you don't throw it. The role of the designer to me is to indicate the door, but the business has to go to it, there's a saying you can bring an ill horse to the river but you can't force it to drink. Its exactly the same here, we can have a lot of discussions about circular economy but if we can't put it in place then the right persons don't take the necessary steps to do it. And why there are so few designers there I have no clue, but maybe some more designers would have helped. But to me that wasn't the problem as I said, because design is not a leadership kind of role inside Organisation B. So its not on our radar.

JG: What is the role of design within Organisation B then?

P: I think its more supportive, connecting dots and seeing the best match. But when we talk about circular economy its completely new, so design should drive there. It should be the first actor in that game. Because its totally new kind of zone so we can't do the same thing that we did for a lot of time in different projects, we have to set in place something new. So to me design has to, in any circular economy approach project, has to lead.

JG: In terms of Organisation B's innovation project then, where does that project fit?

P: It would fit in circular economy approach of course but I don't think that there is a folder for circular economy at the moment within Organisation B. Maybe there is, but another things is that there are two people in charge of circular economy within Organisation B and I wonder why they are not present within that workshop. Anyways, sorry what was the question, oh this project, I think that this project is under the sustainability level because having a chat with the Italy team they mention the words sustainable, sustainability, fully circular, a bright example to follow so its something completely new but I can't really reply to this question outside of that sorry.

JG: I sense that this might revolve around circularity again but did you have any personal motivation going into the project?

P: Yeah, my motivation was that I really like circular economy and since its so innovative I really wanted to be part of a project on circular economy. I have read a lot about it and I can say that in my team I'm the person in charge of circular economy, if there's something then people come to me and ask because I've read so much. I was expecting to be honest something more than a simple pack reduction or something like that. Me and my team developed, we had a small workshop together, maybe 3 or 4 hours and we came up with 3 possible scenarios that were mentioned within the video. Now those scenarios were particularly provocative and we didn't want to go down that particular route, but we wanted just to point out that there are some possible ways that design could tackle instead of having just the same pack reductions that we do all the time to minimise the cost and maximise the profits. So I was expecting something more, I don't know… groundbreaking. Something more provocative, something that everyone would talk about it because its something new. Because Organisation B is an innovative company in certain aspects so I don't know why circular economy is something that we don't really get. So yeah I was expecting something more. And it wasn't about your work guys, you were amazing facilitating the whole thing so it wasn't your fault at all. To me there were no right mindsets in it. I liked the presentations, really liked them and at one point I thought yeah today we are going to do something extremely valuable, especially when the presenter showed us megatrends and how the world is changing. So that's a clear sign of how the world is changing and that's why we need circular economy. Because if we do it nowadays it could be not that profitable but it could be profitable within ten years, fifteen years, five years you never know it. So the more we define the strategy now the more we will be advantaged in the next future. That's why I was expecting more, but as I said the project has got just four years so its not much time to put in place a circular economy approach, so maybe that's why people from there thought four years are a very short time and we can't afford to do any more that this. So that's comprehensible but I don't know, maybe some more energy would be useful.

JG: Who is it that sets the deadlines for projects like that?

P: Ok so wave one was about light-weighting, and wave two was about how we can trigger circular economy in this particular project. So wave two was 2020, so four years. Its a very short time, so that's why to me the Italy team didn't understand circular economy at all because four years its a very short time.

JG: Did they set that deadline or was that set for them?

P: I don't know that

JG: Ok, outside of yourselves and the Italy team, were there any other stakeholders within Organisation B that would have an interest in the project?

P: I don't think so but I'm not sure about it. To me no, but take it with a pinch of salt.

JG: Going into the project, do you think that the anticipated value from the Italy team was specifically around the pack reduction?

P: So the aim of the project was to maximise the profit by 50%, that was the aim of it. And to me that was already a bad assumption because if you want to put in place a circular economy approach and you really want to do it, that has to be the first driver. That together with pack reduction, you can't do both, you have to pick one and choose which one is more important than the other. I think the Italy team was expecting some road map or way to action the findings of the workshop in some way that they could continue and that's why they are waiting so much time, because they don't know what to do now. I'm not quite sure about that though because I'm not sure what's going on in their minds at the moment. From my team's perspective, as I said we were expecting a little bit more, especially because we built our expectation because the Italy team told us that they really wanted circular economy, you have your free hands move as you want, lets just do it. So we were really really excited about that so even if we were doubtful, and that's why we realised that we were doubtful, because they probably under rated the word circular economy.

JG: On the day when people were coming up with ideas, a few people dismissed some of the ideas on the basis that maybe it wouldn't be appealing to the marketing people within Organisation B. Is that a fair comment based on your experiences?

P: Oh yes, its a true statement. There were people there that were a little bit strict about new possible routes to take just because the bottle is like that and we can't change the bottle, the liquid is like that and we can't change the liquid, everything is as it is and we don't want to change anything. So yeah there were some people like that, and to me that's not the right mindset at all because we can maintain the logo, lets say our brand language even doing something else. We are not forced to stay in the same place just because we are winning today.

JG: Is that something that you've seen in other projects as well, where marketing has been a barrier in some respects?

P: Barriers are everywhere, but in circular economy there are too many barriers. In circular economy, I see the values of keeping the brand constant across all variations of the project. It perfectly makes sense, but my experience, not design but human being experience lets say, is that the strongest species are the ones that are most keen to change. Those that can evolve in the best way possible are those that can change and adapt to stick with the environment, those animals are the most powerful and we are not doing that, we just stick with the same plan.

JG: So I have one final question, going forward, if you were to increase multidisciplinary collaboration across the board in Organisation B, what role do you think that design would play in that process?

P: I like multidisciplinary approaches because I think that they are the most valuable to find the best possible solutions, because I come from a multidisciplinary company that I worked for and I think design in that space works more as a connector. So connecting the dots and seeing where the shortest circuit is and how we can trigger the value for what we are doing. But a multidisciplinary approach is valuable because it allows you to see problems from a variety of perspectives not just design, not just CMI or CTI or whatever. So me a multidisciplinary approach is really valuable, I think design could even take a role of facilitation. Something like it was on the day of the workshop.

Appendix B: Ethics forms

Informed consent forms for organisations

School of Design

Informed Consent Form:

About this Research - The right design competence for successful design led innovation: A study to compare corporate organisation need and higher education development strategy.

Researcher : John Gribbin

Email: john.gribbin@northumbria.ac.uk

Contact School of Design via robert.young@northumbria.ac.uk

This consent form is for individuals who are being invited to participate in the research project seeking to understand the way in which organisations adopt design-led approaches to innovation. The research aims to identify the relationship between knowledge, attitude, skill and capability derived from design-led projects. By consenting to take part in this research, you are agreeing that data can be collected from the project that your organisation has completed alongside Northumbria University.

Participants of the research will take part in individual interviews with a focus on the development of design within the organisation throughout the Knowledge Transfer Partnership (KTP) in collaboration with Northumbria University. It is expected that the research will generate insights into the development of design-led innovation throughout the KTP, with a particular focus on the individual and organisational knowledge developed throughout the process.

All data gathered throughout the process will be anonymised. As an organisation, you have the right to withdraw from the project at any point whilst the initial research is being carried out, without fear of judgement. You also have the right to withdraw after the completion of the data collection. All data collected from individuals will then be anonymised. Furthermore, the final narrative of all publications can be sent to the organisation for approval and will be published upon approval. Please feel free to ask any questions that you may have about the research or the organisation's role within it before providing your consent.

Information obtained in this study, including this consent form, will be kept strictly confidential (i.e. will not be passed to others), and anonymous (i.e. individuals and organisations will not be identified unless this is *expressly required and consented to separately in writing)*.

Data obtained through this research will not be used for purposes other than those outlined above *without your separate written consent*.

Participation is entirely voluntary and you may withdraw at any time within the next *three* months, for any reason, without any need to explain. Where results have not been analysed and published, your data will be destroyed on request.

By signing, dating, and initialling below, you indicate that you fully understand the above information and agree to participate in this study on this basis.

I, on behalf of my organisation, consent to the organisation's participation in this study and the use of collected data as described above.	Sign: Date: Position within the organisation:
I consent to this use of any recorded materials, (Photos, Audio, and Video), in research presentations/ research publications/including Internet publications.	Initial:

Thank you for consenting to participate in this research

Please keep one copy of this form for your own records

School of Design

Informed Consent Form:

About this Research - The right design competence for successful design led innovation: A study to compare corporate organisation need and higher education development strategy.

Researcher : John Gribbin

Email: john.gribbin@northumbria.ac.uk

Contact School of Design via robert.young@northumbria.ac.uk

This consent form is for members of Organisation A and Northumbria University, who are being invited to participate in the research project seeking to understand how organisations adopt design-led approaches to innovation. The research aims to identify the relationship between knowledge, attitude, skill and capability derived from design-led projects.

As a participant, you are consenting to a semi-structured interview that will concentrate on the role of design within Parker and it's development over the course of the Knowledge Transfer Partnership in collaboration with Northumbria University. All data from the interviews will be kept anonymous. Any recordings made by the researcher will be transcribed, with a coding system being used to identify participants, thus guaranteeing further anonymity. Any recordings made by the researcher will be kept until completion of the study, and then securely erased.

Information obtained in this study, including this consent form, will be kept strictly confidential (i.e. will not be passed to others), and anonymous (i.e. individuals and organisations will not be identified unless this is *expressly required and consented to separately in writing)*.

Data obtained through this research will not be used for purposes other than those outlined above *without your separate written consent*.

Participation is entirely voluntary and you may withdraw at any time within the next *three* months, for any reason, without any need to explain. Where results have not been analysed and published, your data will be destroyed on request.

By signing, dating, and initialling below, you indicate that you fully understand the above information and agree to participate in this study on this basis.

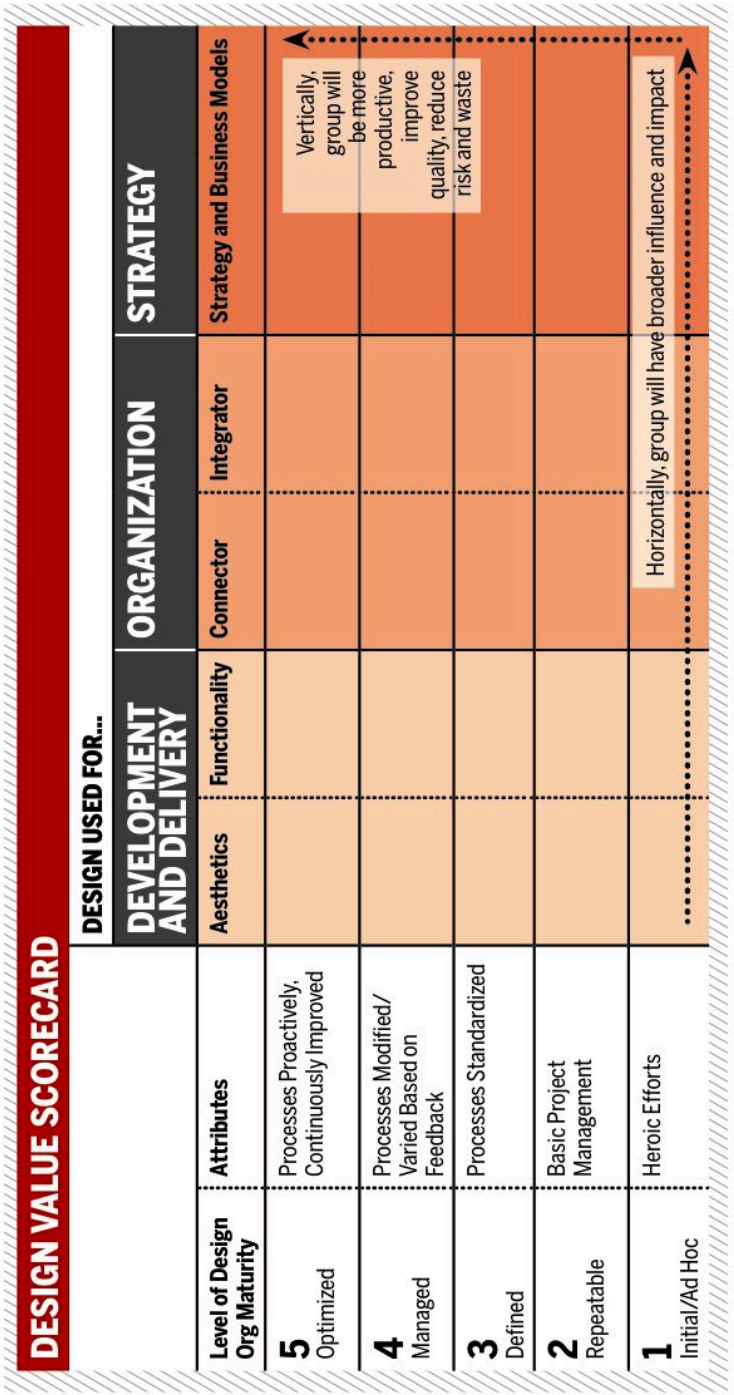
I consent to my participation in this study and the use of collected data as described above	Name: Sign: Date:
I consent to this use of any recorded materials, (Photos, Audio, and Video), in research presentations/ research publications/including Internet publications.	Initial:

Thank you for consenting to participate in this research

Please keep one copy of this form for your own records

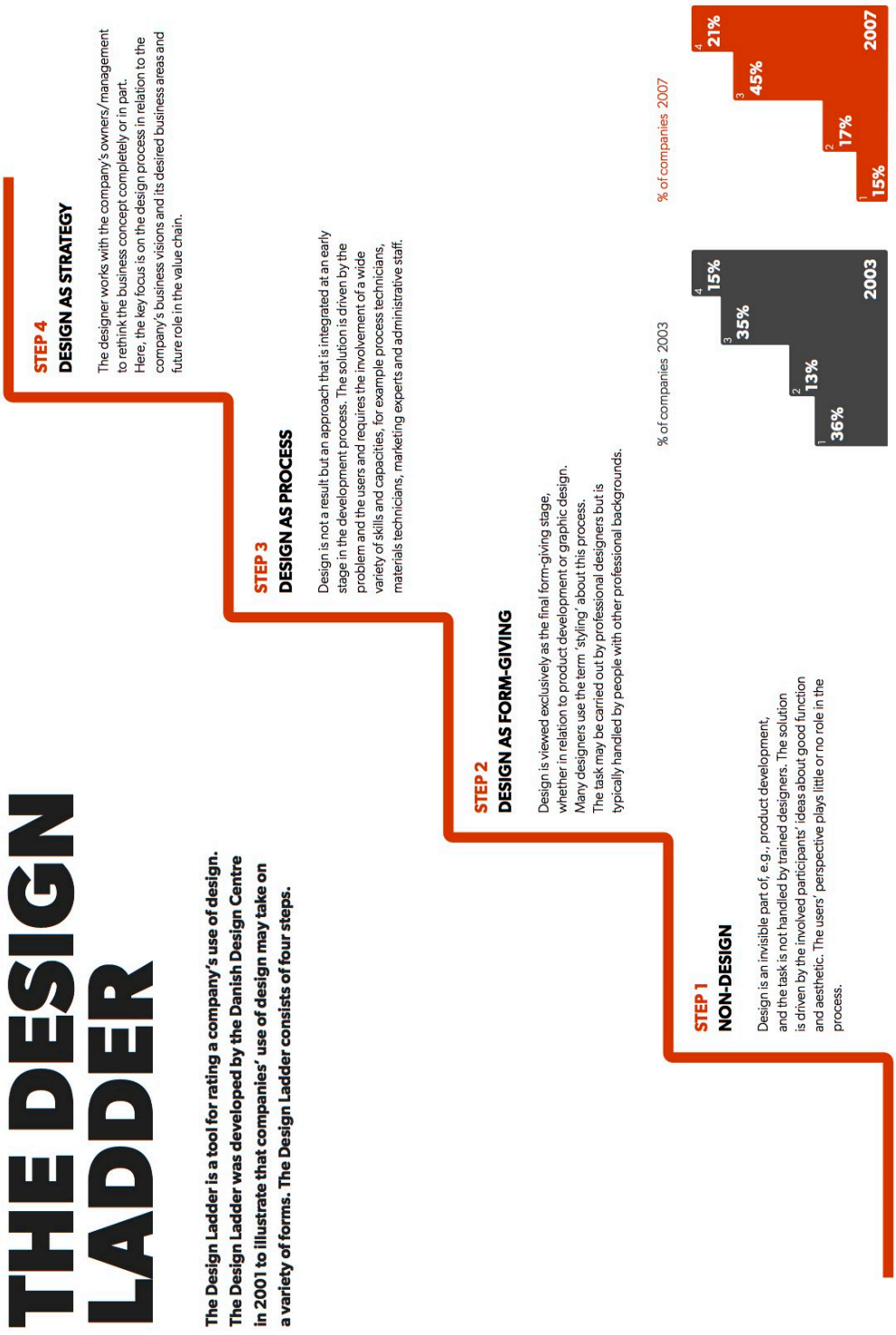
Appendix C: Maturity framework examples

Design Management Institute value index
(Westcott et al., 2013).



Danish design ladder

(Danish Design Centre, 2015).

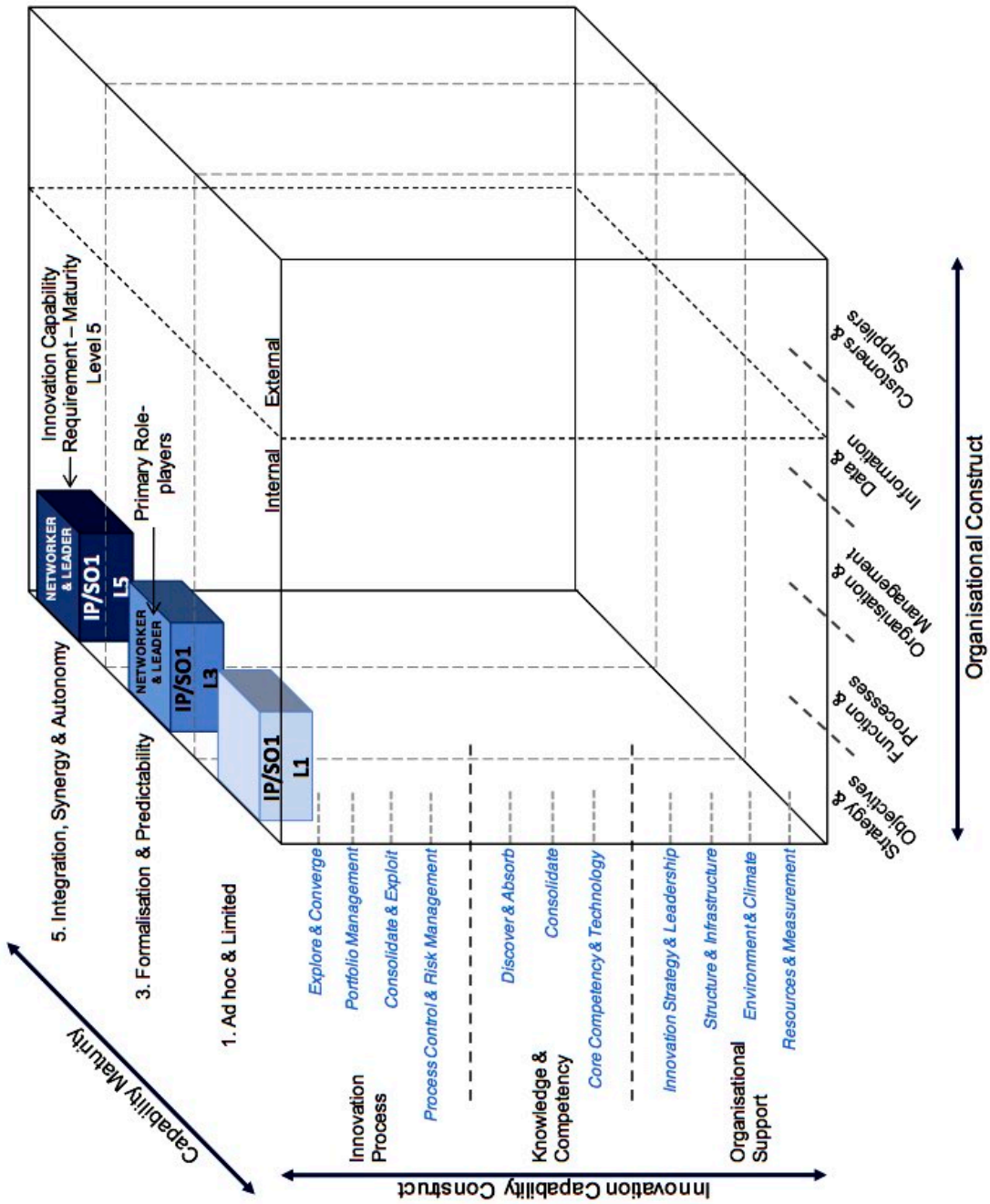


Philips framework

(Gardien and Gilsing, 2013).

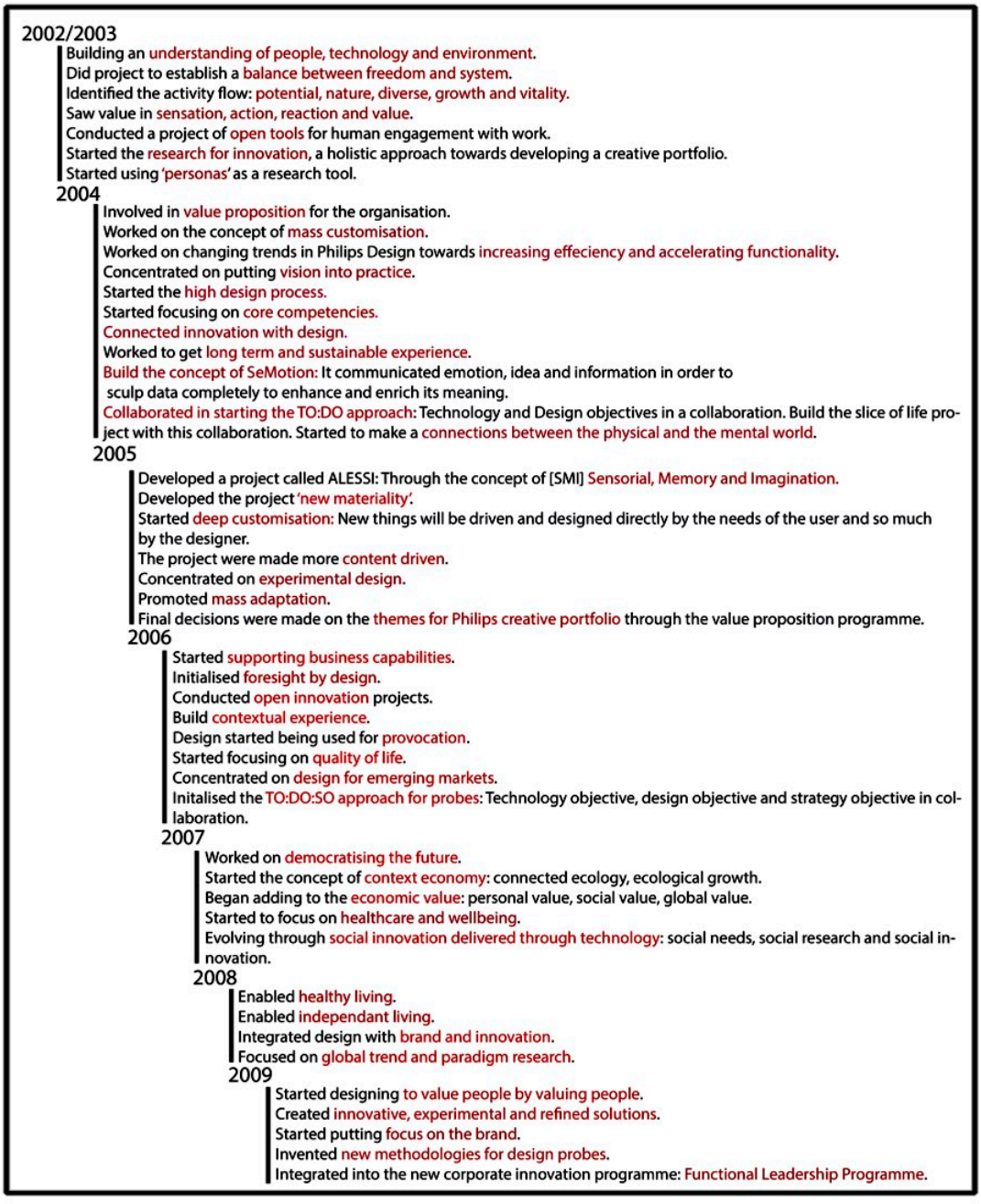
	MATURITY LEVEL 1: WITHIN FUNCTION BUT IN CONTEXT	MATURITY LEVEL 2: INTEGRATED AND ALIGNED WITH OTHER FUNCTIONS	MATURITY LEVEL 3: MEASURABLE IMPACT ON BUSINESS RESULT AND OTHER FUNCTIONS
DESIGN STRATEGY	• Design strategy leads to design objectives, KPI's and improvement programs.	• Integral part of all short, medium and long term business objectives.	• Measurable influence on the long term vision and direction of the company.
DESIGN PROGRAMMING	• Design programs are derived from business programs. • Prioritization based on business needs.	• Participation in business programming and road mapping leads to design programs. • Prioritization based on potential return.	• Integral part of management decision process. • Measurable influence on the direction of business programs.
DESIGN DELIVERY	• Design process defined. • Resourcing within the function. • Receiving design brief.	• Design process and resource planning integral part of business process and footprint business. • Ownership on briefing process.	• Design delivery strategy based on measurable effectiveness and efficiency and supports future value creation.
DESIGN TO INNOVATE	• Programmed contribution to innovation projects. • Aligned with innovation themes.	• Front-end activities ensuring uptake. • Design as co-author of innovation roadmap and research themes, including front-end.	• Design and design thinking contributes to redefinition of existing markets and categories. • Pushing new paradigms, e.g. ecosystems.
DESIGN TO DIFFERENTIATE	• Contributing to the creation, management and orchestration of total brand touch points per category.	• Design facilitates the coherency of brand expression across all touch points.	• Design thinking contributes to defining the direction of the brand strategy and identity.
DESIGN TO OPTIMIZE	• Contributing to simplifying and value engineering design solutions	• Design facilitates creation of optimizing platforms, roadmaps and standardization on a program level.	• Design thinking contributes to optimized processes, portfolios and value chain (end to end).
DESIGN SKILLS	• Access to all design expertise's (comm. prod. serv....) • Talents identified. • Job rotation within the organizational entity (Sector).	• Internal and external design expertise leveraged in projects. Succession planning leads to new design leaders. • Job rotation within the function (Company).	• World class design expertise's. • Talent management extending to partners and universities. • Design thought leadership recognized as benchmark
COMPETENCE DEVELOPMENT	• Areas for best practice defined. • Relevant Design information available and accessible.	• Internal and external collaboration increases competence and knowledge level. • Knowledge dissemination embedded in w.o.w.	• Design competence recognized as benchmark. • Design knowledge integrated in business knowledge management, contributing to learning organization.
CULTURE FOR DESIGN	• Little awareness in the organization on the full potential of design to create business value. • Design seen as costs.	• High awareness that investments in design are essential for NPS, brand equity and innovation.	• Design provides inspiration at a strategic level, while supporting direction setting and the creation of meaningful solutions on an operational level.

Innovation capability maturity model
(Essman and du Perez, 2009).



Appendix D: Timeline of Philips Design

(Aftab, 2013)



Appendix E: Coding examples

	Design as capability	Culture for design	1a	And so the way I talk to the design engineers about the introduction of industrial design is, we're getting bigger, we're evolving, we can afford now to specialise a little bit more in this front end. And, you know, when you see the type of work that they do, and when you expose some of the design engineers to the kind of work that, you know, [redacted] is doing, the industrial designs are doing, they can look at it and they can see, "That's not really what I've been trained to do. Or if it was what I was trained to do it was a long time ago and I only did a fraction of that. And my training is, there's an overlap, but my training is more, you know, to the right and their training is more to the left.	The way in which the introduction of design was explained to engineering in order to reduce resistance.
	Design as capability	Culture for design	1a	And so, I mean, I haven't, you need to try to find interesting work for those engineers, so the design engineers, so they don't feel threatened by it. But on the other hand, you know, you're getting a lot more from the industrial designer, if you can afford that specialism. Which is where we are today.	The way in which the introduction of design was explained to engineering in order to reduce resistance.
	Design as capability	Culture for design	1a	Not that I can recall, no, it was more about job security and it was about the loss of the creative aspect.	Resistance mainly stemmed form concerns of job security and involvement in the creative aspects of projects.
	Design as capability	Culture for design	1a	I think it's the problem that we've talked about, that some of it is seen as sexy stuff at the start and they don't like to miss out.	Resistance mainly stemmed form concerns of job security and involvement in the creative aspects of projects.

	Design as capability	Culture for design	2a	Yeah I mean it gets brought up showing other divisions what we are doing and how we are looking forward, we'll show them that we're using industrial design and how it's helping us to move forward and understand our customers more. People at a corporate level can see the value of industrial design as well because they've seen some of the work that's been going on.	Corporate awareness of the benefits that design has brought to completed projects.
	Design as capability	Culture for design	2a	What did I want from it? I guess I wanted to be more involved in more innovation. I saw it as a way of getting there. That's really why I still like working with industrial design because I'm working on a lot of small projects, like I said before. It still gives me involvement in innovation on larger new product developments. So I mean that's why I got into engineering in the first place because I love innovation. So basically that's what I really wanted from that side of it to get more of that across, more out of the box ideas and more quickly visualising different ideas.	Desire to innovate from within the engineering department which aligns with the introduction of design into the organisation.
	Design as capability	Culture for design	2a	More products. More increases in sales. So the more they can see it, because being in a PowerPoint presentation or a little video is one thing but actually seeing significant growth is another thing.	Communicating the benefits of design to employees to increase awareness of it's value to innovation.
	Design as capability	Culture for design	2a	I think the other thing that we've done is we've raised awareness of industrial design in other locations around the world. So now people are thinking about it. We regularly get other divisions coming to us saying, "We've got this project, can we borrow ?"	Communicating the benefits of design to employees to increase awareness of it's value to innovation.
	Design as capability	Culture for design	2a	It's become very... yes, everyone has become aware that that's an important function. I'm not really sure because I mean we obviously went through the interview process for the KTP colleagues and there were a number of people that impressed but obviously you need to get a number of candidates in to see how they would fit. But certainly seems to be quite a talented guy. He's very good at sketching.	Recognition that design adds important value to the innovation process of the organisation.

Appendix F: Critical incidents tables

Organisation A timeline:

0	No design intervention
1-2	Visual branding project
3-4	KTP initiated
7-8	Application of technology to new markets project
13-14	Organisation restructure
15-16	New engineering manager hired
17-18	Idea lab completion
21-22	Mapping design's role within the organisation's innovation process
27-28	KTP ended/Designer hired in permanent post
35-36	Time of interviews

Organisation B timeline:

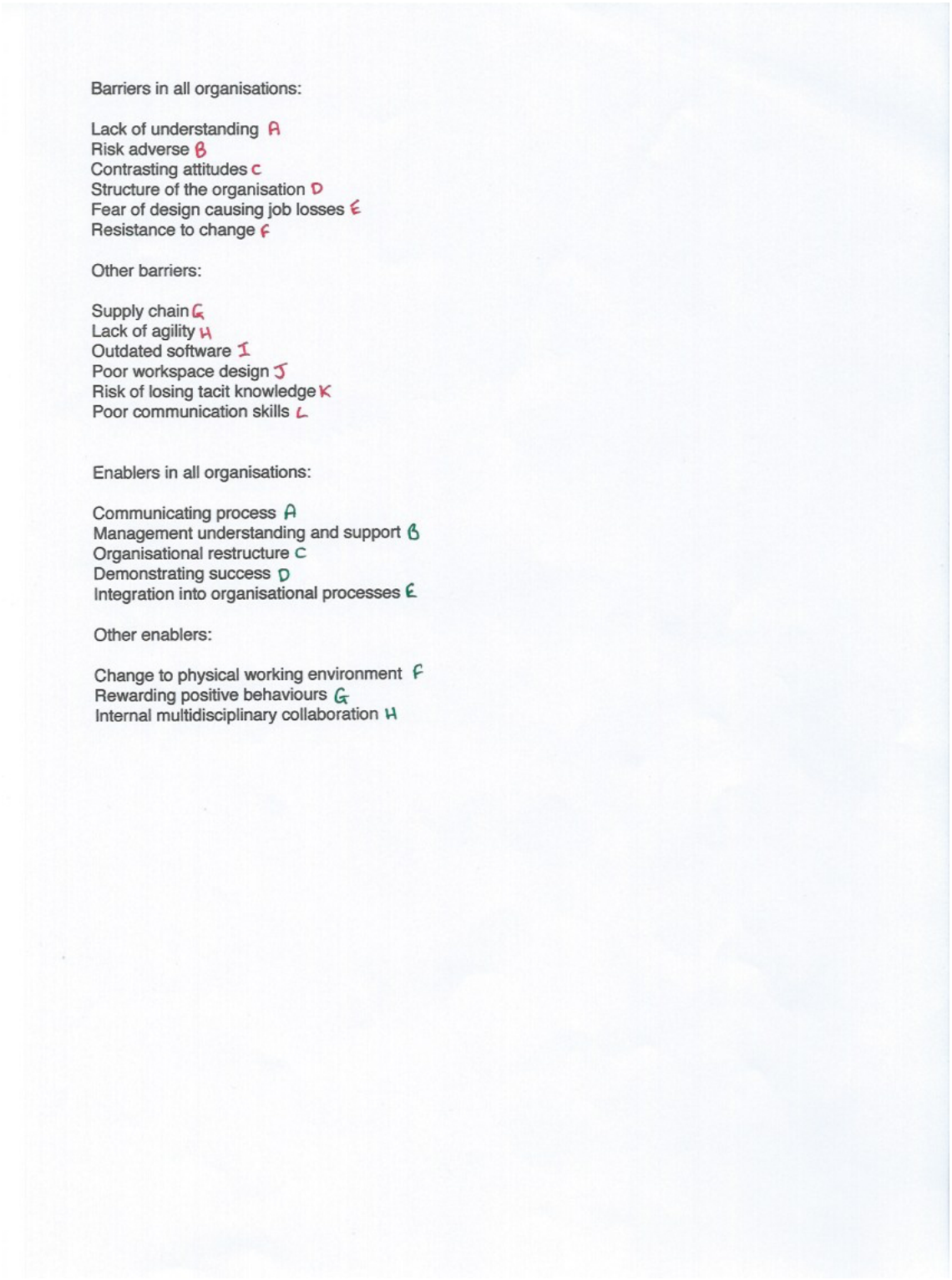
0	Organisation restructure
1-2	New design director hired
19-20	Second design director hired
19-26	Six month window in which design was given space to understand purpose
31-32	Italy project
36-36	Time of interviews

Organisation C timeline:

0	No design intervention
1-2	Control cabin project
2-4	End of control cabin project
5-6	Start of University collaboration
19-20	Time of interviews

Appendix G: Barrier and enabler mapping

Codes for barriers and enablers



Barriers in all organisations:

Lack of understanding A
Risk adverse B
Contrasting attitudes C
Structure of the organisation D
Fear of design causing job losses E
Resistance to change F

Other barriers:

Supply chain G
Lack of agility H
Outdated software I
Poor workspace design J
Risk of losing tacit knowledge K
Poor communication skills L

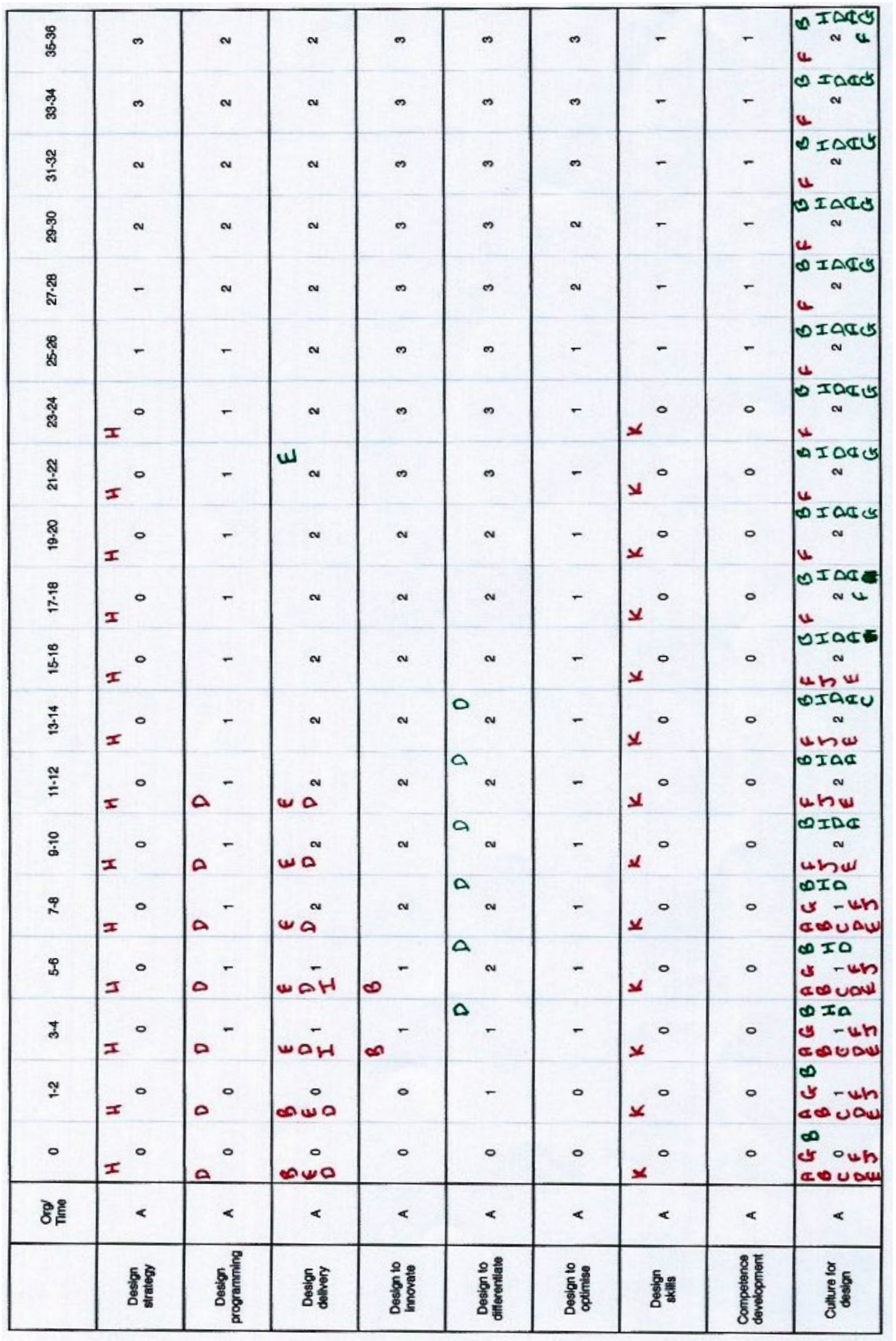
Enablers in all organisations:

Communicating process A
Management understanding and support B
Organisational restructure C
Demonstrating success D
Integration into organisational processes E

Other enablers:

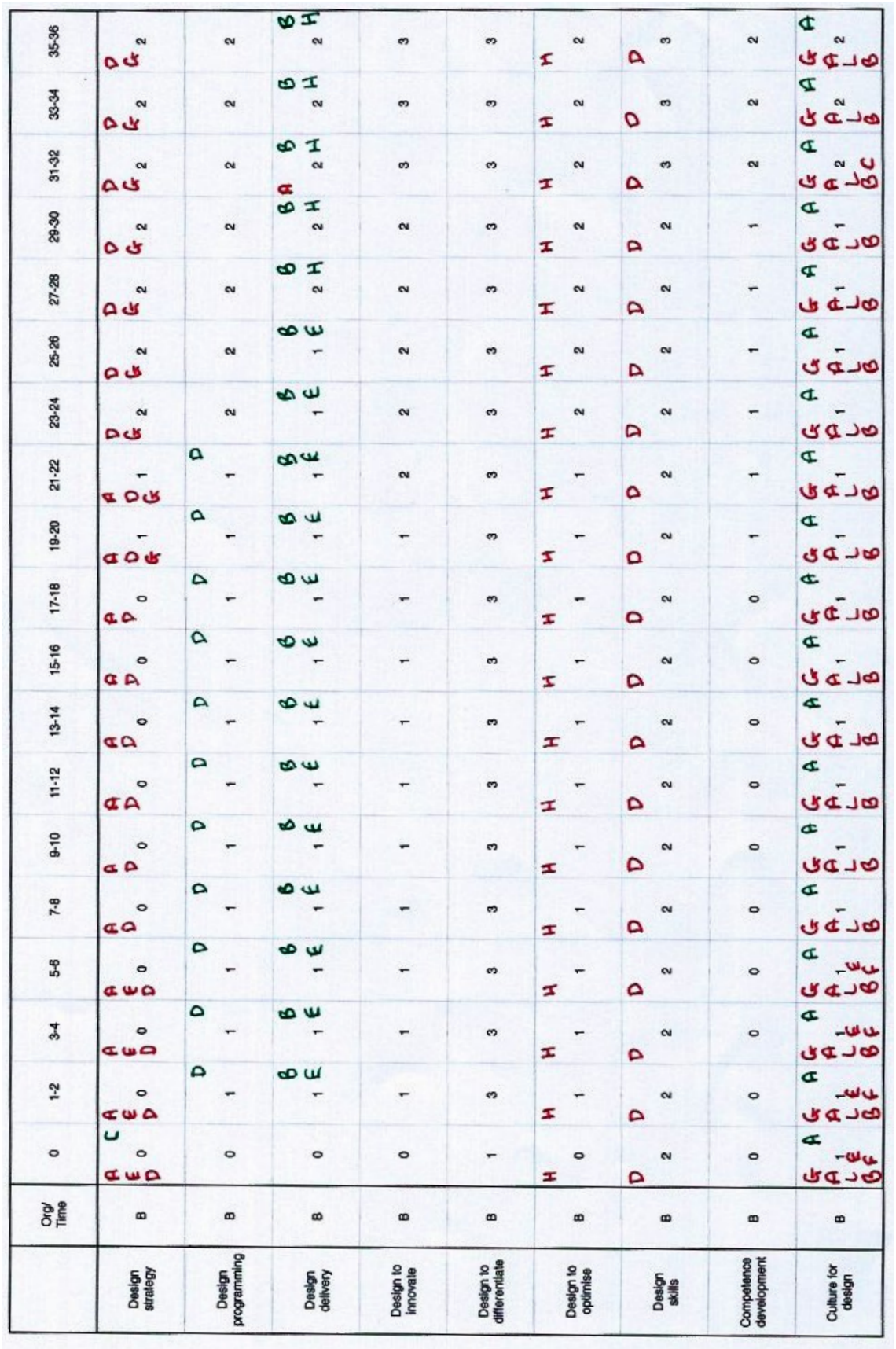
Change to physical working environment F
Rewarding positive behaviours G
Internal multidisciplinary collaboration H

Organisation A barriers and enablers



	Org/ Time	0	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36
Design strategy	A	H	H	H	H	H	H	H	H	H	H	H	H	H						
		0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3
Design programming	A	D	D	D	D	D	D	D												
		0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
Design delivery	A	B	B	E	E	E	E	E					E							
		0	E 0	D 1	D 1	D 2	D 2	D 2	2	2	2	2	2	2	2	2	2	2	2	2
Design to innovate	A	0	0	1	B 1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3
Design to differentiate	A	0	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3
Design to optimise	A	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	3	3
Design skills	A	K	K	K	K	K	K	K	K	K	K	K	K	K	1	1	1	1	1	1
		0	0	0	0	0	0	0	0	0	0	0	0	0						
Competence development	A	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
Culture for design	A	A G B 0 B C D E	A G B - C E F	A G B H D - E F	A G B H D - E F	A G B B C D E	B F F E 2	H D A 2	C	E	F	G	G	G	G	G	G	G	G	G

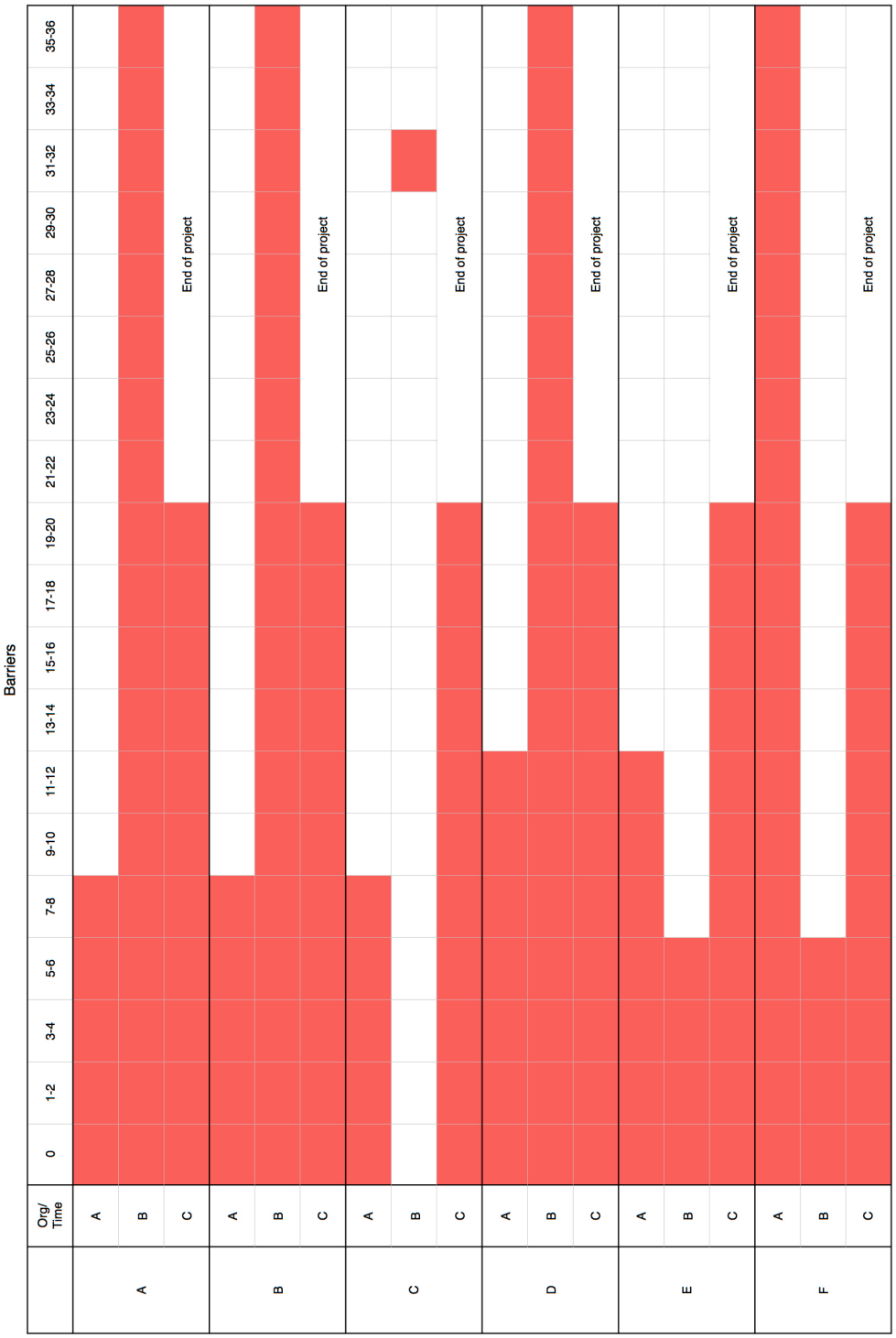
Organisation B barriers and enablers



Organisation C barriers and enablers

	Org/ Time	0	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36
Design strategy	C	0	0	0	1	1	1	1	1	1	1	1								
Design programming	C	D 0	D 0	D 1	D 2	D 2	D 2	D 2	D 2	D 2	D 2	D 2								
Design delivery	C	A 0	A 0	A 0	A 1	A 1	A 1	A 1	A 1	A 2	A 2	A 2								
Design to innovate	C	0	0	0	B 2	B 2	B 2	B 2	B 3	B 3	B 3	B 3								
Design to differentiate	C	0	0	0	0	0	0	0	0	0	0	0								
Design to optimise	C	0	1	1	A 2	A 2	A 2	A 2	A 2	A 2	A 2	A 2								
Design skills	C	0	0	0	0	0	0	0	0	0	0	0								
Competence development	C	0	0	0	0	0	0	0	0	0	0	0								
Culture for design	C	F A 0 C E B	B 0 C 1 A E B	F C 1 A E B	B C 1/2 D F A E C	F B C 1/2 D E B	B C 1/2 D E F	B C 1/2 D E F	B C 1/2 D E F	F B C 1/2 D E F	B C 1/2 D E F	B C 1/2 D E F								

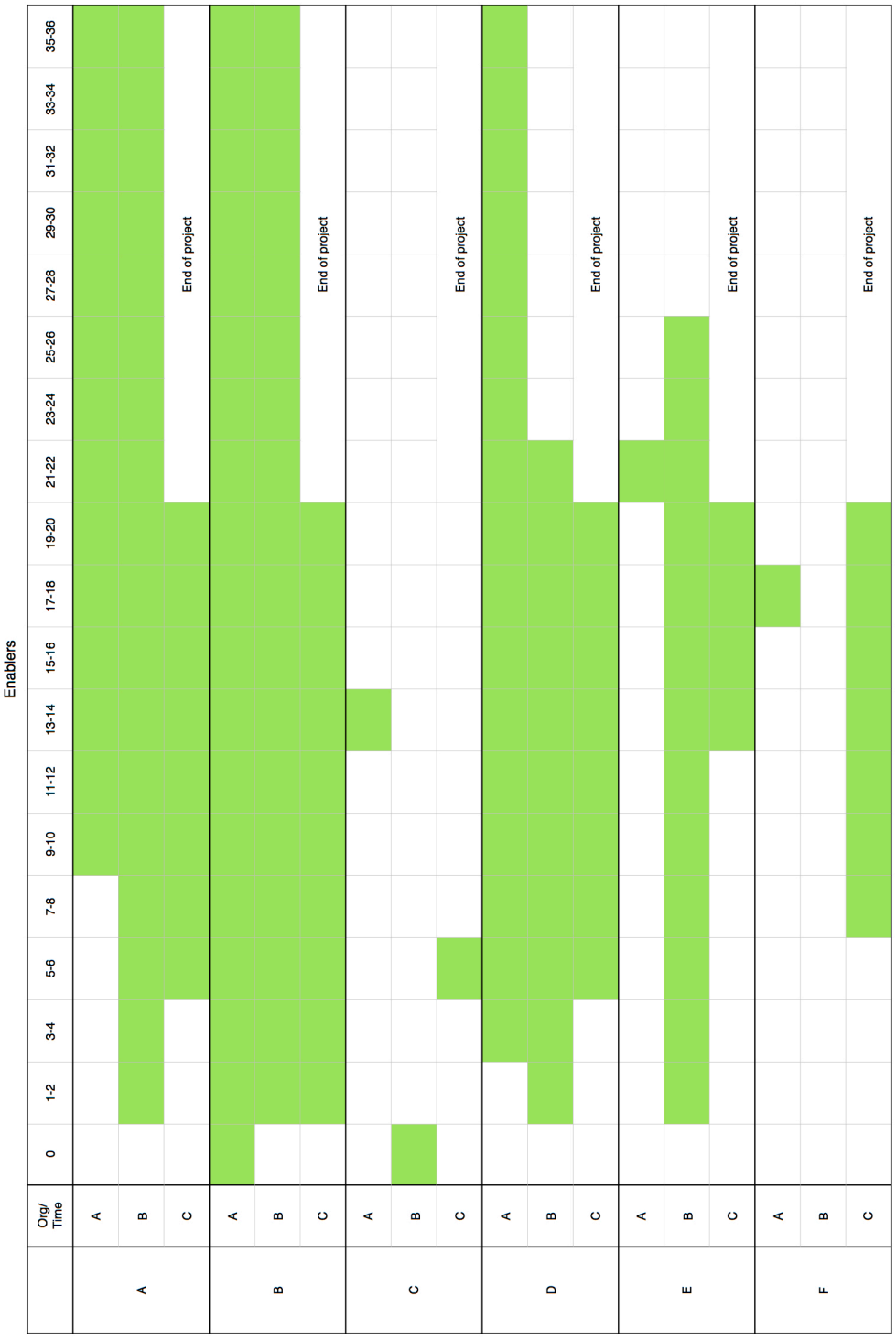
Cumulative timeline of barriers



Barriers

	Org/ Time	0	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36
G	A																			
	B																			
	C															End of project				
H	A																			
	B																			
	C															End of project				
I	A																			
	B																			
	C															End of project				
J	A																			
	B																			
	C															End of project				
K	A																			
	B																			
	C															End of project				
L	A																			
	B																			
	C															End of project				

Cumulative timeline of enablers



Enablers

	Org/ Time	0	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36
G	A																			
	B																			
	C											End of project								
H	A																			
	B																			
	C											End of project								

Appendix H: Sample table from inquiry audit process

Interview participant	Type of design	Code	Interview quotation	Researcher's comments	Inquiry audit response
Org A Emma	Design as approach Design programming	2a	Yeah, I think so. I think there are pockets certainly on the… it has attracted attention. It starts off with the people who are on the technology side with a corporate and are sort of interested in how that can be developed. I think, I mean I haven't really had any discussions with anyone very senior in the corporation about what their view is on it. But my impression is that we're sort of being used as the seed location and then, if we develop something, you know, if it grows, if it shows to have benefit then I can imagine us being used as a case study for elsewhere. So I think they're open to us experimenting but they're not necessarily pushing it as a corporate initiative.	Design beginning to influence the organisation at a senior level. Interest in ongoing projects is emerging with the potential to scale up design if upcoming projects are successful.	Judging from the quote alone i would think that design programming is at a vary early stage and it is still used as some kind of testing ground, without any policy. I would say 0a instead of 2a, since they're still looking at the potential need or purpose of a design programme.
Org A Isaac	Design as approach Design strategy	0a	When I started I was initially put with marketing because they weren't quite sure where to place industrial design so the relationship has always been positive, they get it, they understand and I get asked quite a lot to join in on projects more than engineering because they aren't quite as forward thinking for the business if that makes sense.	Design integrated into marketing rather than being classified as an individual function.	Agree
Org A Isaac	Design as approach Design delivery	0a	So we do actually do post-launch reviews and stuff like that. When it came to it, no one had actually used that feature to sell the product so it was like, "Right, we've spent months solving these issues and really, if we just got the feedback from the customer, we might have found that that's just not what they wanted."	Projects carried out in isolation previously, even separated from the final customer.	Agree

Org C Claire	Design as capability Culture for design	1b	I think they need to buy into it in terms of financially. I think they do need support on different levels in terms of things like what does this actually mean for them in the company and how they put the frameworks in place which help guide how they split up teams and form teams which are going to be able to do this. So I think the theory is there but they'll probably need support in practice.	Financial considerations of design still at the forefront of decision making.	Agree
Org C Philip	Design as outcome Design to innovate	2b	I think at the top end, the CTO, me, some of the MDs and other guys in the innovation side, there is a change. It's a more open minded change, lets actually think about the market rather than just the next customer that rings up.	Thinking more about the market than being dictated to by potential customers.	I'm not sure what this person's position is, but judging from what they say, the top level management is more open to design now. So it could also be Design programming 3a or Design to innovate 3a, since it was mentioned that they're moving more open to looking at what the market does (which could imply redefining it as well?)
Org C Philip	Design as approach Design delivery	1a	If you said supporting and leadership I'd say it would be somewhere in the middle of there. Connecting almost.	Able to define the role that design is now playing within the organisation.	Agree, but unfortunately I don't know enough of the context of the statement to suggest otherwise.
Org C Harry	Design as approach Design delivery	1a	And I was quite encouraged that at the end of that presentation, you were all, the members of the team all pick up on that, they recognise the value for what's sitting out there, but more importantly, for me, they recognised how, the way and which we did that, was valuable and could add value to SMD.	An understanding from people within the business that the methods and approach of design strategy are important.	Agree, although depending on the context, could also be design to optimise 0a.

Org B Chris	Design as approach Design delivery	1a	But yes design has made a few changes. The first one was about tools, we brought simulation, CAD and prototyping into existence within Unilever. So before we came in, prototyping within Unilever was done by external design agencies so prototyping in its most basic form of creating objects was alien to us and we brought that stuff in which changed how we did workshops completely. Simulation too, there was an absolute change of how mould management was done because you needed simulation to verify a number of things in the mould management process.	Establishing design tools within the organisation's working processes.	Agree, although it could also be design to optimise 1a, since it was mentioned that prototyping and simulation had some positive effects on some work processes.
Org A Mark	Design as outcome Design to differentiate	3a	Then we brainstormed, developed maybe 40 different concepts and then we picked three or four or five and said, "Okay, let's sketch them up." So then when we went back to see the customer another year later, between the first visit and the second visit, the second visit we went back and we said, "It's us again but we'd like to talk about our new approach." Then that got them on the hook and we said, "We're now taking a more customer centric approach to design. We're not just going to show up and say, "There you are, we've done this." We'd like to work with you, we'd like to understand your application more." We don't know everything but we've already had some initial ideas and we showed some concepts, albeit in sketch format. The customer was completely blown away. They were saying, "That's the first time we've seen any supplier come with that approach." Therefore the customer said, "You've demonstrated that you are the sort of business that we want to work with," which was really cool.	Clear change in thinking strategy going into customer meetings since the introduction of design.	Agree
Org B Penny	Design as capability Culture for design	1a	I think that was a great opportunity for design and business to find a new landscape, but sometimes people don't get the value.	Design struggles to describe value to other disciplines.	Agree

Appendix I: Papers published as a result of the research study

2016 Design Research Society: 50th Anniversary Conference

DRS2016
Design + Research + Society
Future-Focused Thinking

2016 Design Research Society
50th Anniversary Conference
27-30 June 2016, Brighton, UK

Paper title: Double-loop reflective practice as an approach to understanding knowledge and experience.

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Abstract: The main aim of this paper is to consider the way in which reflective practice can assist practitioners in better understanding their individual knowledge and experience. Transitioning from a design novice to a design expert is described as a vague process, in which reflective practice can offer a level of understanding that provides an important insight into professional development within design. Through a comparison of two methods of reflection and analysis of reflective practice data, it is argued that repertory grid interviews have the potential to be a catalyst for double-loop learning within individuals; providing people with a platform to reflect on their beliefs and values in addition to their approach towards problem solving. This argument is based on the ability of repertory grids to uncover some of the implicit knowledge developed by designers, which is a distinct advantage to alternative methods of reflection and which is necessary to improve professional practice understanding and learning.

Keywords: Reflection, Design knowledge, Design experience, Repertory grids.

1. Introduction

Within design practice, reflection is critically important in translating experience into the development of new skills, attitudes, knowledge and capabilities. This is epitomised by Schön (1991), who argues that experience alone does not necessarily lead to learning and that a deliberate reflection on action is necessary in order to fully understand one's experiences. The resulting experience, knowledge and intuition become critical in a designer's attempt to solve complex problems and navigate a design space when creating innovative solutions. Experienced designers have the capability to apply their knowledge to any given context and this paper will consider the way in which reflective practice can

support this, by allowing practitioners to become more aware of their knowledge and experiences.

Within the leadership function of organisations, Aftab (2013) identifies that designers can typically be categorised into thinkers and practitioners. Design thinkers are those who work with strategies and solutions to problems facing organisations in the distant future (over twenty years) and consequently have an involvement in the formulation of the future of the company. Contrastingly, practitioners are those who work to create scenarios that are applicable in the present, in terms of relevant products and services. In doing this, they follow the direction provided by the thinker in order to achieve the goals identified for the future. Both of these roles require a variety of tacit, implicit and explicit knowledge, however this paper argues that propositional and non-propositional knowledge stand out as a key differentiator between the two roles.

The authors of the current paper take the viewpoint of outside researchers looking into organisational innovation practices, as opposed to that of a reflective practitioner reflecting upon their own actions. It also follows the belief that not all knowledge can be explicated, however it is the role of researchers to uncover and document as much of this knowledge as possible. This is a viewpoint underpinned by Polanyi (1958), who argues that not all types of knowledge can be understood; instead some types of knowledge such as the arts have limited capability for transfer; they cannot be transferred by prescription, since no prescription for it exists. Subsequently the only way for this type of knowledge to be transferred is from person to person, such as from an expert to a novice. As a result, it is only possible to explicate a finite amount of knowledge in any given situation.

The intention of the paper is to consider methods that will translate as much of the implicit skills and knowledge of the design practice process as possible, which merges into tacit elements. The paper will begin with a discussion of knowledge in relation to design professionals, before considering the relationship that knowledge has with experience.

2. Knowledge within design

2.1 Thinkers and practitioners

The articulation of design knowledge entails defining what designers 'knowingly-think' (explicit knowledge), 'knowingly do' (implicit skills) and 'unknowingly do' (tacit knowledge). In reality, most knowledge in design practice has been claimed to be either tacit or implicit (Cross, 1984), or a combination of both (Smith, 2001). Furthermore, Young (2008) confirmed that certain forms of implicit knowledge can be made explicit such as 'craftsmanship and its strategy' in the form of a design outcome, but this is not likely the case for other forms of tacit knowledge, which are both hard to understand as well as difficult to articulate explicitly.

Polanyi (1958) and Wilson (1999) provide two different and rather contradictory views on knowledge. Whilst Polanyi believes that certain types of knowledge will always remain tacit

and inbuilt in human intellect, Wilson provides the concept of consilience, which maintains that in future all branches of knowledge will be known, made orderly and organised. Arguably, design knowledge poses a challenge to Wilson's notion of consilience, as knowledge in design has been a contentious matter, which is made worse because of the conflict between design theory and its practice. The evidence collected during an investigation with multinational organisations (Aftab 2013) also confirmed this conflict; where the thinkers and the practitioners within the innovation team were divided in their knowledge, way of working and priorities. Thinkers in the organisation proved to have a strong foundation of propositional knowledge (Gemma 2014), based on an awareness of 'how' an innovation process should work to overcome future challenges. Contrastingly, the practitioners held the working knowledge of 'what' needs to be done to make innovation happen on a day-to-day basis; more closely aligning practitioners with a foundation of procedural knowledge (Niedderer 2007).

Both thinkers and practitioners hold two very important types of knowledge, i.e. explicit knowledge and implicit skills. Nevertheless, there was one peculiar knowledge type that existed in both the groups, and was very difficult to articulate i.e. tacit knowledge. Casakin (2007), Cross (2008), Pugh (1990) have all identified where tacit knowledge resides within design activities, but the ways in which this knowledge could or can be made explicit and recognised by the practitioner is still inchoate.

2.2 Articulating knowledge and experience in design innovation practice

Aftab (2013) confirms that the explicit definition of certain aspects of design knowledge, such as process, methods, and tools for design, is essential in order for design to gain and maintain a functional leadership role within an organisation. This involves making sure that every individual working within the innovation process (whether a thinker or a practitioner) is aware of what they are doing, to improve their design performance in problem solving; a process that Schön (1987) named as *knowing-in-action.* Schön described, *Reflection-in-action* as having a critical function, questioning the assumption structure of *knowing-in-action*, more commonly also known as critique (Evans, Powell, and Talbot, 1982). Schön (1987, pp.39) explained that individuals reflect on their way of thinking which places them into a particular situation; and through this process of reflection these individuals may reorganise strategies of their action, understanding the experience, or techniques of problem framing.

It is important to note here that knowledge appears to develop through experience within design practice, where experiential knowledge becomes an important factor underpinning the decisions made by practitioners. Novices tend to solve problems by attempting to represent and classify the problems by their surface features, whereas experts represent them in terms of their underlying features (Chi, Feltovich et al. 1981). Robinson (2010) highlights that experts are at a great advantage in solving complex problems, in that they

have a richer store of relevant knowledge and an ability to conceptualise it in ways that enable them to perceive possible problem solutions. Voss (1989) further emphasises this view, indicating that good problem solving emerges from a person having a substantial knowledge base integrated with knowing how to apply that knowledge to a wide range of problem contexts. This suggests that as designers gain more experience, their overall competence in terms of solving complex problems also increases. Their exposure to a variety of problem situations provides a solid basis from which they are able to draw experience and tailor their abilities towards the new problems that they face. The next section will further consider the role of experience within the development of design professionals.

3. Experience within design

Lawson and Dorst (2009, p.216) argue that expertise within design is not acquired in a continuous seamless manner, instead it is suggested that there appear to be more or less distinct layers of expertise that allow different modes of thinking and action. It is widely believed that experts differ from novices in that experts are aware of a greater number of concepts, organise information on the basis of identifying principles and are capable of applying concepts in a flexible fashion contingent on the key characteristics of a situation (Mumford, Marks et al. 2000). Transitioning from novice to expert is of core importance when considering the journey of a design professional, however there is much debate surrounding the distinction of individual experience levels that occur on this journey. Heskett (2002) writes about this process as layering, where new developments through experience are added over time to what already exists. In this context, layering is a useful term to describe the process by which design knowledge is formed by integrating 'designerly' approaches to identify the richness of design activity. The journey from novice to expert is documented in the rest of this section and is summarised in Appendix 2.

Perhaps the most extensively utilised model of skill acquisition is provided by Dreyfus and Dreyfus (1986, 2002), who suggest that there are five stages in the human skill acquisition process with an individual transitioning from novice to expert with increasing exposure to skilful practice. The first stage of novice occurs when a person is provided with rules for determining actions within a given situation, which they will follow rigidly until they reach the desired outcome. The learner then transitions to advanced beginner when they have gained experience working within real situations and learned that the rules don't necessarily apply to all situations. Furthermore, this is the stage in which experience becomes more important than any form of verbal description. Upon gaining a certain amount of experience, people then enter the competency phase, in which the number of recognisable context-free and situational elements present in a real-world circumstance eventually become overwhelming. People learn a hierarchal procedure of decision making in order to solve these problems, by choosing a plan to organise a situation and examining the most important factors to that plan.

When people enter the two highest levels of skill, their approach to problem solving is characterised by a rapid, fluid, involved kind of behaviour that contrasts to the problem solving approaches used within the lower levels. Proficient learners are capable of considering the rules to a situation, before making conscious choices of both goals and decisions after reflecting upon a range of alternatives. Proficiency is only developed if experience is assimilated in a way in which intuitive behaviour replaces reasoned responses (Dreyfus 2002). The expert performer differs from the proficient performer in that the expert is capable of seeing what needs to be achieved and sees how to achieve their goal. With enough experience, the expert is capable of providing an immediate intuitive situational response to a problem, due to their experience in a variety of different situations.

Within design practice, Lawson and Dorst (2009) criticise the use of the Dreyfus framework in that design is not just limited to people who are formally trained in the subject. This leaves questions surrounding a framework that begins at the novice level, given that people are capable of designing without even realising that they are doing so. Despite this, Lawson and Dorst (*ibid*.) argue that the Dreyfus framework provides a strong foundation to encourage thinking about the development of expertise in design. Dorst (in: Poggenpohl and Satō 2009) takes measures to build on the Dreyfus framework in a way that addresses his earlier critique; suggesting that a 'naïve' level should be added in order to precede the novice stage of skill. The 'naïve' state of designing is adequate for explaining the design-like tasks that non-designers carry out in their day to day life, in which people have unsystematically gathered experience. Furthermore, Dorst (*ibid*.) proposes an additional level of experience, superseding mastery, in the form of a 'visionary', in which a person becomes so interested in developing new ideas that the normal level of expected professional competence becomes less important. The work of such designers may often not be realised but it is deemed necessary as visionaries are explicitly redefining the design field that they are working in. This is echoed by Sennett (2008), who refers to craftsmen in society who are capable of utilising their mastery in order to change the methods and tools of their craft in order to contend with the evolving nature of the problems and contexts that they are working within.

Ultimately, this leads to a refined framework of experience that could be mapped against a range of design career paths, however there are still questions that need to be answered in order for these types of frameworks to comprehensively explain the way in which individual designers develop mastery of their subject. The existing framework is particularly oriented around the skills of a designer, when arguably other factors must also be considered to provide a comprehensive explanation of a designer's expertise. Aspects such as knowledge and attitude also play an important role in design problem solving and should be reflected in future frameworks. Furthermore, it can also be difficult to recognise when people are transitioning from one level to the next. Dorst (in: Poggenpohl and Satō 2009) argues that in order for people to progress they must first acquire sufficient knowledge within a particular level. Next they must undergo a mental realisation that their newly acquired knowledge and

skills can be utilised in a new and different way. This paper argues that reflection is capable of being a catalyst for this process, as the leap from one level of experience to the next can be a difficult transition for individual learners.

4. Reflection and double-loop learning

Schön (1991) argues that within the context of design, experience alone does not necessarily lead to learning and that a deliberate reflection on action is necessary. In order for people to translate their tacit understanding and implicit skills and experiences into learning and explicit knowledge, they must engage with the process of reflection in order to articulate this value. Being able to reflect upon experience in this way can help individual learners to align their individual competencies within a given framework of expertise and form a better understanding of their development as a design professional.

Schön and Argyris (1974) highlight two different learning strategies that involve experience-based learning and can be driven by the process of reflection and is visualised within figure 1. The first strategy is single-loop learning that involves the creation and adoption of new action strategies in order to understand inner values. This often takes the form of problem solving with individuals attempting to improve the systems they operate within. Contrastingly, double-loop learning occurs when people focus on the improvement of their inner values as opposed to merely understanding them. People begin to question the underlying assumptions behind their techniques, goals and values in order to understand why they do what they do, as emphasised by Cartwright (2002, p.68) who indicates that 'double-loop learning is an educational concept and process that involves teaching people to think more deeply about their own assumptions and beliefs'. Within the context of these two strategies, the purpose of reflective practice is to allow individuals to describe a world that more faithfully reflects the values and beliefs of the people in it (Greenwood 1998).

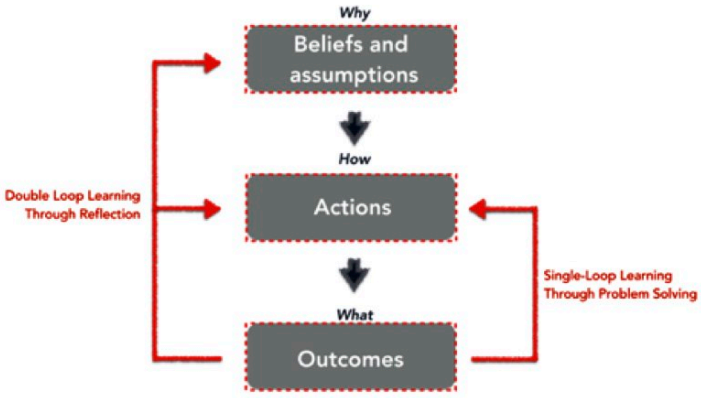

Figure 1: Single and double-loop learning.

According to Argyris (1976), double-loop learning is focused upon improving the problem solving capabilities of people who are involved in solving complex and ill-structured problems, which are capable of evolving as problem solving advances. This makes double-loop learning especially desirable within the context of design-led organisations, where both thinkers and practitioners are typically expected to solve problems that operate within these boundaries (Rittel and Webber 1973, Stacey, et al. 2000, Coyne 2005, Dorst 2011). Furthermore, this style of learning is pertinent within cultures that embrace failure and view it as an important tool for learning (Liepė and Sakalas 2015). This is an approach typically favoured by organisations seeking to engage with radical innovation by following design-led innovation practices (Verganti 2009). In this situation, organisations that learn how to fail intelligently consistently outperform those that seek to minimise the frequency of failure (Schrage 1989, Sudheim 2013).

Double-loop learning can therefore be used to help both organisations and practitioners better understand the underlying beliefs and assumptions that govern their actions. In the case of organisations, this can benefit innovation practices, by improving performance when solving wicked problems that present themselves. With regards to individual practitioners, double-loop learning can provide individuals with a more holistic learning experience, ensuring that individuals are better aware of their professional experiences, which is of great importance within practice-led professional learning. With these benefits in mind, the next section will discuss the methodology that the paper adopts in considering which methods are most appropriate in facilitating double-loop learning.

5. Methodology

This paper follows the approach of grounded theory, combined with case study analysis in order to investigate methods that are capable of facilitating reflection. Grounded theory was initially proposed by Glaser and Strauss (1967) as a 'systematic generating of theory from data that itself is systematically obtained from social research' (Glaser, 1978 in: Hussein, et al. 2014). It is an inductive method of generating theory through the simultaneous collection and analysis of data, with the goal of generating relevant and significant knowledge through social research. Grounded theory has limitations in that researchers can often blur methodological lines by selecting purposeful instead of theoretical sampling (Charmaz 1990), which must be controlled by sampling based on emerging theory. Within this paper, the goal of grounded theory was to derive fresh insights into existing case studies and as such, the sampling was guided by the selection of relevant cases.

Yin (2014) identifies case studies of empirical enquiry that investigate a contemporary phenomenon in depth and within its real-world context; particularly when the boundaries between phenomenon and context may not be clearly evident. Similar to grounded theory, cases provide an opportunity to explore propositions and generate theory from the resulting data. Grounded theory is often limited in terms of its generalisability with theories often only relevant to the context in which they are derived (Stebbins 2001). Combining it with

case study research appears to mitigate the effects of this issue, as the use of multiple cases begins to provide examples derived from multiple experiments that investigate phenomena under different conditions (Lipset, et al. 1956, Hammersley, Foster et al. 2000, Johansson 2003).

Eisenhardt (1989) highlights that case studies typically combine multiple methods, which may be qualitative or quantitative in nature. Within this study the primary data collected was qualitative and collected through workshops that occurred within the setting of design education. The workshops aimed to encourage reflection in twelve multidisciplinary postgraduate students, with the aim of explicating some of the knowledge and skills that were developed over the course of three different design focused projects. The projects in question were all client driven, with the first focusing on stakeholder engagement for a non-profit organisation. The second project aimed to analyse the structure of an organisation through an evaluation of membership platforms available to their clients; whilst the final project was brand driven, offering a fresh perspective on potential avenues of future business development as well as alternative methods of improving customer experience.

6. Analysis of methods

6.1 Introduction

The previous sections of this paper have discussed the importance of reflective practice to both organisational learning and individual design professionals. This section will build on this discussion by outlining the methods that are available to individual design practitioners in order to facilitate reflective practice with the goal of creating double-loop learning. Primarily, an objective researcher has facilitated these methods and assisted in the interpretation of findings in order to maximise the value gained by the reflective practitioner.

6.2 An overview of reflective methods

Reflective practice is common across a wide range of disciplines, with a variety of methods being utilised to facilitate the process. In order to analyse some of these methods in more detail, Appendix 1 provides an in depth overview; outlining a definition of each method alongside any advantages and disadvantages noted by other studies, as well as highlighting any studies that utilise the method to facilitate reflection.

Due to the scope of the paper, it is impossible to further discuss each method of reflection individually; therefore the remainder of the paper will discuss methods that appear to be most relevant in facilitating double-loop learning within design practitioners. Whilst all of the mentioned methods are effective when it comes to facilitating reflection, not all of the methods are capable of eliciting implicit knowledge and skill leading to the tacit dimension, which reduces their appropriateness for this work.

6.3 The repertory grid technique

Although workshops facilitated with interviews and observations proved to be a useful tool in understanding the explicit knowledge that is held by practitioners, they only offered a small insight into the implicit elements that contribute to professional practice. As a result, it is important to consider methods of reflection that are capable of beginning to uncover some of this knowledge. Appendix 1 shows that repertory grid interviews fit these criteria. Subsequently this section will consider the merits of the approach as a reflective method.

A repertory grid is a method for eliciting personal constructs in relation to a given topic. The method was derived by Kelly (1955), who expressed that people are continually engaged in the process of devising new theories, testing hypotheses based on these theories and acting on their findings (Giles 2002). Kelly (1955) described this process as personal construct theory, arguing that individuals construct rational worlds based on their experiences, which shape a pattern that can be defined as 'personal constructs'. Candy (1990) describes a system of personal constructs as a repository of what a person has learned, a statement of their intent and the values by which they live. As a person builds up their construction of reality, more and more constructs are derived until eventually a complex and unique picture of one's reality is formed; thus demonstrating the way in which a person organises their social world, which is then open to interpretation.

Repertory grids are often utilised in order to facilitate the articulation of various personal constructs. A repertory grid takes the form of a table or matrix that can contain either quantitative or qualitative data. Tables consist of columns of elements, which define the area of study and rows of constructs, which are themes that link various elements together (Giles 2002). Constructs within the grid are always bipolar, meaning that they comprise two opposing values, which helps to ensure that they can be distinguished from other concepts. This process is perhaps best described by Persson (2009, p.254), who expresses it within the context of an interview situation:

"If Anne is interviewed and the topic is [her] friends she might say that Mary and John are nice and Sally is not. This is the elicitation of one pole of a construct but it would not be complete without the other pole. Anne will now describe the attribute that Sally has that is contrasting to nice. If she says that Sally is unpleasant compared to the other two, the two poles of the construct [are] nice and unpleasant. Anne will then rank all the elements, her friends, according to a scale. The procedure continues until it is no longer possible for Anne to elicit more constructs."

When conducting a repertory grid interview, the facilitator can ask questions in a way that target both emergent and implicit constructs (Fransella, Bell et al. 2004). Emergent polls can be derived by asking a person to explain the way in which two elements of a triad are in some important way similar and thus different from the third element. In order to uncover

implicit constructs, the facilitator can then ask how the third element is different from the two that were stated to be similar. Björklund (2008) suggests that eliciting constructs in this way allows researchers to understand the implicit learning that occurs through the progression of a professional craftsman from novice to expert. The repertory grid technique can elicit implicit constructs and patterns that would not be possible to elicit through regular ordinary interview techniques as the information is not stored in verbal form. Therefore, asking participants to consider implicit constructs in this way begins to uncover some of the tacit knowledge that they possess.

One of the biggest advantages of the repertory grid technique is that it can be used in facilitating double-loop learning for individual practitioners. The aim of personal construct theory is to document a person's reality with regards to individual situations, which can be directly utilised when understanding the beliefs and assumptions that underpin their decisions within a particular context (Kelly 1955). Furthermore, the technique can provide an insight into the tacit knowledge held by practitioners (Jankowicz 2004), which is hugely beneficial in the design profession where both thinkers and practitioners need to become more aware of the tacit factors that contribute to their overall expertise.

As a research method, repertory grids are particularly useful in understanding the views of others without misinterpretation from an outside source (e.g. a researcher). It is easy to talk to a person and believe that we have understood them, however unless their personal constructs are well understood there is a risk that our own thinking will simply be transferred to the situation (Jankowicz 2004). By highlighting as many personal constructs as possible and ensuring that the person reflecting spends time developing bipolar constructs, there is minimal interruption from the facilitator leading to a specific insight into a situation, thus reducing the potential for bias as a research method.

Authors such as Tofan *et al*, (2011) and Anderson (1990) find that when using the repertory grid technique within different situations, one of the main disadvantages is the time that it takes to implement the method particularly in relation to alternative psychometric tests. Equally, Tofan (*ibid*.) highlights that participants can find it difficult to interpret the data that they create when reflecting through this method. Subsequently, the implementation of the method as a tool for reflective practice would have to be carefully facilitated in order to guide participants in both creating and interpreting their own grids. Despite this drawback, the repertory grid technique appears to be one of the most useful techniques for encouraging reflection and double-loop learning within design thinkers and practitioners. They are a viable tool in uncovering the personal constructs of individuals, which provides an insight into the tacit and explicit knowledge and experience that they have acquired in their practice. As a result it is possible that the repertory grid can be utilised in order to help thinkers and practitioners better understand their experience in relation to a given framework of expertise.

6.4 A reflection on the repertory grid process

One of the primary aims of the pilot study was to explore whether it was possible to implement the repertory grid technique in a workshop setting, rather than through individual interviews. The success of the method under these circumstances would have allowed a researcher to provide a greater ownership of the method to the participants, resulting in a method capable of facilitating double-loop learning without an independent researcher having to guide the process. From this, it would have been possible to utilise the method in a greater range of circumstances, as it would be less resource intensive to implement it. However, the data provided by the students in the workshop setting was consistent with the approach of single-loop learning, with a large focus on the methods that were used throughout the projects and little comparison of the deeper beliefs and assumptions that underpinned decisions. Within a one on one interview process, it is possible for a researcher to overcome this issue by using a process of laddering, in which constructs of a higher order of abstraction can be elicited (Fransella, Bell et al. 2004). Laddering involves the elicitation of constructs through triadic comparisons, before asking a person to say by which pole of each construct they would prefer to be described. From this they are asked to consider why they prefer that particular construct and the advantages to that construct as they see them (Hinkle 1965). This process allows the students to consider the system through which they are working in much greater focus.

The results of the workshop also provided an interesting insight into the attitudes of the students taking part in the projects. Through conducting a correlation analysis on the numerical ratings that students gave to each individual construct, it was possible to determine which aspects of the projects were statistically related. This highlighted the aspects of each project that students found engaging and which they found frustrating. This is of importance to researchers investigating a growing body of research surrounding design attitude (Boland and Collopy 2004, Michlewski 2006, Nelson and Stolterman 2012). This type of study frequently investigates the factors that designers and people from a broader range of disciplines find engaging and frustrating when collaborating across innovation projects; which is essential when trying to derive a picture of the culture of an organisation.

Furthermore, the students themselves responded positively to the method when asked how they felt about the process. They particularly felt that the comparison between projects made through repertory grid gave it a distinct advantage over the other methods of reflection that they had previously utilised. Through the comparison of different projects, they were made to think differently about the skills and knowledge that they had developed over multiple projects and were given the opportunity to consider how these aspects of their competency had been developed over time. Perhaps most importantly, the students appeared engaged throughout the entire process, as it is critical that a method of reflection has this effect as if the opposite is true it is unlikely that people will fully engage and that any double-loop learning will occur.

7. Conclusion

7.1 Summary

The main aim of this paper was to consider the way in which reflective practice could assist practitioners in better understanding their experiences, in order to improve their overall practice. Design knowledge is often referred to as being episodic, in that it is derived through our experiences (Lawson and Dorst 2009). Authors such as Chi *et al.* (1981), Robinson (2010) and Voss (1989) all highlight that knowledge develops with experience of design practice; resulting in experts being able to problem solve more effectively than others who may be less experienced. Despite this, Dorst (in: Poggenpohl and Satō 2009) indicates that we are still unaware of the way in which a professional might increase their considered level of expertise. Transitioning from novice to expert can be a vague process, however there are clear distinctions as to the steps that occur along the way. It is argued that reflective practice can help practitioners to understand their own experience and knowledge, in turn assisting them as their expertise develops over their careers.

The paper adopted a methodology of grounded theory and case study analysis to consider a range of reflective methods that could give practitioners a better insight into their experience. Through workshops, it was determined that design professionals appear to develop the specialist knowledge associated with the role of thinkers or practitioners when they begin their career within an organisation (Aftab, 2013). Furthermore, in certain situations, effective reflective methods need to allow a person to reflect on the influence of others as well as themselves in the decision making process. From the methods analysis, it appears that the repertory grid technique has the potential to be a suitable method for enabling double-loop learning within design professionals, with its ability to uncover tacit knowledge being a particularly strong advantage over the alternative reviewed methods.

Repertory grid has the potential to be utilised as an independent form of enquiry, however for best results it should perhaps be combined with a form of reflective or reflexive conversation. The current study utilised workshops as a way of facilitating these conversations, engaging with multiple practitioners at the same time in order to efficiently collect data. Repertory grid also needs to be facilitated by an objective researcher in order to guide the process and encourage the participant to reflect on appropriate incidents. Further research should look to implement this approach and document the findings in relation to mapping out the experience of design practitioners.

7.2 Implications for future work

An argument has been constructed, through a limited empirical study, in favour of the use of repertory grids as an effective method to create double-loop learning in design practice. It appears to be the most effective method of reflection that is capable of uncovering tacit knowledge within practitioners whilst allowing people to reflect deeply on their beliefs and assumptions as well as their actions in a given situation. To further this work, studies should

seek to implement the repertory grid approach across design professionals from a range of experience levels in order to ascertain relationships; between levels of experience and breadths and depths of explicit, implicit and tacit knowledge and whether and how these might reinforce double-loop learning to support the growth of professional knowledge. Such studies would further validate the method's appropriateness in helping individual designers to better understand their design practice and as a result help to improve their overall performance. Also, they would help reduce the vagueness of the process of designers transitioning from a novice to an expert practitioner and how this relates to descriptions of competence in organisations.

8. References

Aftab, M. (2013) Design as a functional leader: A case study to investigate the role of design as a potential leading discipline in multinational organisations. (PhD), Northumbria University.

Al-karasneh, S. M. (2014) Reflective Journal Writing as a Tool to Teach Aspects of Social Studies. *European Journal of Education, 49*(3), 395-408.

Anderson, N. (1990) Repertory grid technique in employee selection. *Personnel Review, 19*(3), 9-15.

Argyris, C. (1976) Increasing leadership effectiveness. New York: Wiley.

Björklund, L. (2008) The Repertory Grid Technique: Making Tacit Knowledge Explicit: Assessing Creative Work and Problem Solving Skillls.

Black, A. L., & Halliwell, G. (2000) Accessing practical knowledge: how? why? *Teaching and Teacher Education, 16*(1), 103-115.

Bolland, R., & Collopy, F. (2002) Managing as designing. Calafornia: Stanford University Press.

Butterfield, L. D., Borgen, W. A., Amundson, N. E., & Maglio, A.-S. T. (2005) Fifty years of the critical incident technique: 1954-2004 and beyond. *Qualitative research, 5*(4), 475-497.

Candy, P. (1990) Repertory grids: Playing verbal chess. In J. Mezirow (Ed.), Fostering critical reflection in adulthood: a guide to transformative and emancipatory learning (pp. 271-295): Jossey-Bass Publishers.

Cartwright, S. (2002) Double-loop learning: A concept and process for leadership educators. *Journal of Leadership Education, 1*(1), 68-71.

Casakin, H. P. (2007) Metaphors in design problem solving: Implications for creativity. International Journal of Design, 1(2), 21 - 33.

Charmaz, K. (1990) 'Discovering' chronic illness: Using grounded theory. *Social science & medicine, 30*(11), 1161-1172.

Chi, M. T., Feltovich, P. J., & Glaser, R. (1981) Categorization and representation of physics problems by experts and novices. *Cognitive science, 5*(2), 121-152.

Cope, J., & Watts, G. (2000) Learning by doing-An exploration of experience, critical incidents and reflection in entrepreneurial learning. *International Journal of Entrepreneurial Behavior & Research, 6*(3), 104-124.

Coyne, R. (2005) Wicked problems revisited. *Design Studies, 26*(1), 5-17.

Cross, N. (1984) Developments in Design Methodology. John Wiley, Chichester.

Cross, N. (2008) Designerly ways of knowing. Berlin: Birkhauser.

Dorst, K. (2011) The core of 'design thinking' and its application. *Design Studies, 32*(6), 521-532.

Dreyfus, H. (2002) Intelligence without representation – Merleau-Ponty's critique of mental representation The relevance of phenomenology to scientific explanation. *Phenomenology and the Cognitive Sciences, 1*(4), 367-383.

Dreyfus, H., & Dreyfus, S. (1986) Mind over machine: The power of human intuition and expertise in the era of the computer. New York, USA: The Free Press.

Eisenhardt, K. M. (1989) Building theories from case study research. *The Academy of Management Review, 14*(4), 532-550.

Evans, B., Powell, J., and Talbot, R. (1982) *Changing Design*. England: Page Bros.

Francis, D. (1995) The reflective journal: A window to preservice teachers' practical knowledge. *Teaching and Teacher Education, 11*(3), 229-241.

Fransella, F., Bell, R., & Bannister, D. (2004) *A manual for repertory grid technique* (2nd ed.).

Gemma, W. (2014) The 6 types of knowledge: From a priori to procedural. Retrieved from https://blog.udemy.com/types-of-knowledge/

Giles, D. (2002) Advanced research methods in psychology. New York: Routledge.

Glasser, B., & Strauss, A. (1967) The discovery of grounded theory. Strategies for qualitative research. Chicago, Illinois: Aldine Publishing Company.

Goodfellow, J. (2000) Knowing from the inside: Reflective conversations with and through the narratives of one cooperating teacher. *Reflective practice, 1*(1), 25-42.

Gray, D. E. (2007) Facilitating management learning developing critical reflection through reflective tools. *Management learning, 38*(5), 495-517.

Greenwood, J. (1998) The role of reflection in single and double loop learning. *Journal of advanced nursing, 27*(5), 1048-1053.

Hammersley, M., Foster, P., & Gomm, R. (2000) Case study and generalisation. In R. Gomm, M. Hammersley, & P. Foster (Eds.), *Case study method: Key issues, Key texts* (pp. 98-115). London, United Kingdom: Sage.

Hassenzahl, M., & Wessler, R. (2000) Capturing design space from a user perspective: The repertory grid technique revisited. *International Journal of Human-Computer Interaction, 12*(3-4), 441-459.

Heskett, J. (2002) Toothpicks and logos: Design in everyday life. United Kingdom: Oxford University Press.

Hill, K., Wittkowski, A., Hodgkinson, E., Bell, R., & Hare, D. J. (2015) Using the Repertory Grid Technique to Examine Trainee Clinical Psychologists' Construal of Their Personal and Professional Development. *Clinical psychology & psychotherapy*.

Hinkle, D. (1965) The change of personal constructs from the viewpoint of a theory of construct implications. (PhD) Ohio State University.

Hughes, H., Williamson, K., & Lloyd, A. (2007) Critical incident technique. Exploring methods in information literacy research. Topics in Australasian Library and Information Studies, 28, 49-66.

Hussein, M. E., Hirst, S., Salyers, V., & Osuji, J. (2014) Using grounded theory as a method of inquiry: Advantages and disadvantages. *The Qualitative Report, 19*(27), 1-15.

Jankowicz, D. (2004) *The easy guide to repertory grids*. London, United Kingdom: John Wiley & Sons.

Johansson, R. (2003) *Case study methodology.* Paper presented at the the International Conference on Methodologies in Housing Research, Stockholm.

Kearns, K. P., Livingston, J., Scherer, S., & McShane, L. (2015) Leadership skills as construed by nonprofit chief executives. *Leadership & Organization Development Journal, 36*(6), 712-727.

Kelly, G. (1955) The nature of personal constructs. *The psychology of personal constructs, 1*, 105-183.

Korthagen, F. A. J. (1993) Two modes of reflection. *Teaching and Teacher Education, 9*(3), 317-326.

Lawson, B., & Dorst, K. (2009) *Design expertise*. Jordan Hill, Oxford: Elsevier.

Liepė, Ž., & Sakalas, A. (2015) The three-loop learning model appliance in new product development. *Engineering Economics, 58*(3).

Lipset, S. M., Trow, M., & Coleman, J. (1956) Union democracy: The inside politics of the International Typographical Union. *Glencoe, Ill.: Free Press. LipsetUnion Democracy: The Inside Politics of the International Typographical Union1956*.

Michlewski, K. (2006) Towards an understanding of the role the culture of desingers can play in organisations. (PhD). Northumbria University.

Moore, R. A., & Aspegren, C. M. (2001) Reflective conversations between two learners: Retrospective miscue analysis. *Journal of Adolescent & Adult Literacy*, 492-503.

Mumford, M. D., Marks, M. A., Connelly, M. S., Zaccaro, S. J., & Reiter-Palmon, R. (2000) Development of leadership skills: Experience and timing. *The Leadership Quarterly, 11*(1), 87-114.

Nelson, H., & Stolterman, E. (2012) The design way. Massachusetts: MIT Press.

Niedderer, K. (2007) Mapping the meaning of knowledge in design research. *Design Research Quarterly*, 2(2), 4-13.

Paton, M. (2012) *Reflective journals and critical thinking.* Paper presented at the Proceedings of The Australian Conference on Science and Mathematics Education (formerly UniServe Science Conference).

Persson, H. (2009) *Repertory grid technique - a window to professional thinking?* Paper presented at the PATT-22 conference, Delft, the Netherlands.

Phani, A. S. (2012) Reflective learning in a large core course in mechanical engineering.

Poggenpohl, S. H., & Satō, K. (2009) Design integrations: research and collaboration: Intellect Books.

Polanyi, M. (1958) Personal knowledge: Towards a post-critical philosophy. Chicago: University of Chicago Press.

Pugh, S. (1990) Total Design: Integrated methods for successful product engineering. Harlow: Pearson Education.

Pyhtila, J. I., Tofade, T. S., & Beardsley, R. S. (2014) Usefulness Of Reflective Journals In A Continuing Professional Development Process For A Pharmacy Leadership Course. *Pharmacy Education, 14*.

Rittel, H. W., & Webber, M. M. (1973) Dilemmas in a general theory of planning. *Policy sciences, 4*(2), 155-169.

Robinson, V. M. (2010) From instructional leadership to leadership capabilities: Empirical findings and methodological challenges. *Leadership and Policy in Schools, 9*(1), 1-26.

Schön, D. (1991) *The reflective practicioner: How professionals think in action* (6 ed.). Aldershot, Great Britain: Ashgate Publishing Limited.

Schon, D. (1987) *Educating the Reflective Practitioner*. San Francisco: Jossey-Bass Publishers.

Schön, D., & Argyris, C. (1974) Theory in practice: Increasing professional effectiveness. San Francisco: Jossey-Bass Publishers.

Schrage, M. (1989) Innovation and applied failure. *Harvard Business Review* (Nov-Dec 1989). Retrieved from https://hbr.org/1989/11/innovation-and-applied-failure

Sennett, R. (2008) *The craftsmen*. Yale University Press.

Smith, E. A. (2001) The role of tacit and explicit knowledge in the workplace. Journal of Knowledge Management, 5(4), 311-321.

Solas, J. (1992) Investigating teacher and student thinking about the process of teaching and learning using autobiography and repertory grid. *Review of Educational Research, 62*(2), 205-225.

Stacey, R. D., Griffin, D., & Shaw, P. (2000) Complexity and management: fad or radical challenge to systems thinking? : Psychology Press.

Stebbins, R. A. (2001) Exploratory research in the social sciences (Vol. 48): Sage.

Sudheim, D. (2013) To increase innovation, take the sting out of failure. *Harvard Business Review*. Retrieved from https://hbr.org/2013/01/to-increase-innovation-take-th&cm_sp=Article-_-Links-_-Top%20of%20Page%20Recirculation

Tofan, D., Galster, M., & Avgeriou, P. (2011) *Capturing tacit architectural knowledge using the repertory grid technique (NIER track).* Paper presented at the Proceedings of the 33rd International Conference on Software Engineering.

Tripp, D. (2011) Critical Incidents in Teaching (Classic Edition): Developing Professional Judgement: Routledge.

Uline, C., Wilson, J. D., & Cordry, S. (2004) Reflective journals: A valuable tool for teacher preparation. *Education, 124*(3), 456.

Verganti, R. (2009) Design-driven innovation: Changing the rules of competition by radically innovating what things mean. Boston, Massachusetts: Harvard Business School Publishing Corporation.

Voss, J. (1989) Problem-solving and the educational process. In A. Lesgold & K. Glaser (Eds.), *Foundations for a psychology of education*. Hillsdale, NJ: Lawrence Erlbaum.

Wilson, E. O. (1999) Consilience: The Unity of Knowledge. New York: Vintage Books.

Yin, R. (2014) *Case study research: Design and methods* (5th ed.). Thousand Oaks, Calafornia: SAGE Publications Inc.

Young, R. (1989) *A refinement of the design process through an analysis of the factors affecting the design of communication control consoles.* PhD thesis, CNAA.

Young, R. (2008) An integrated model of designing to aid understanding of the complexity paradigm in design practice. Futures Journal, Elsevier. 2.

Appendix 1

Reflective processes & methods	Description	Studies	Advantages	Disadvantages
Critical incident analysis	A set of procedures for collecting observations of human behaviour in such a way as to facilitate their potential usefulness in solving practical problems and developing broad psychological principles' (Flanagan, 1954, p.1).	Butterfield et al, 2005; Tripp, 2011; Cope and Watts, 2000; Hughes et al, 2007	Data is collected directly from the participants in their own words. Flexible method for participants to engage with. Highlights key points for personal change/development.	Critical events may not be recognised at the time. People might not recognise the importance of an event within a wider social context. Biased towards events that are considered recent.
Reflective journals	Reflective practice journals give space for regular, frequent, private, explorative and expressive writing (Bolton, 2014).	Uline, 2004; Francis, 1995; Pyhtila, 2014; Al-karasneh, 2014; Phani, 2012; Paton, 2012	Can make different connections between different situations. The writer can share aspects of the journal at their own discretion.	Not everyone prefers to communicate through writing or drawing. May be largely descriptive with little analysis. Difficult to uncover tacit knowledge.
Repertory grids	An interview technique utilised in order to elicit personal constructs and individual beliefs.	Kearns et al, 2003; Anderson, 1990; Hassenzahl, 2000; Korthagen, 1993; Solas, 1992; Hill et al, 2015; Young, 1989	Can be difficult to implement. Elicitation of personal constructs needs to be handled in a sensitive manner. Can be used to explicate tacit knowledge.	The interviewer can access the participants views of their own worlds. Can offer insights into a rich source of data. Construct elicitation comes entirely from the participant, minimal researcher intervention.
Reflective and reflexive conversations	Conversations in which the facilitator asks a series of questions designed to encourage reflection in participants.	Goodfellow, 2000; Moore et al, 2001; Gray, 2007; Black et al, 2000	Can help the process of reflection in action and the search for new perspectives of a situation.	Need to critique assumptions that are made through the process (Palmer and Dumford, 1996).

Appendix 2

The following table collates definitions of the seven levels of experience within design, with definitions taken from: Dreyfus and Dreyfus (1986), Dorst (in: Poggenpohl and Satō 2009) and Lawson and Dorst (2009).

Stage of Expertise	Description
NAIVE	*The Naive state of experience is adequate for explaining the design-like tasks that non-designers carry out in their day to day lives, in which they have unsystematically gained experience in the discipline. This is primarily derived through people engaging with problem solving in a designerly, yet uninformed way.*
NOVICE	*A novice will consider the objective features of a situation, as they are given by the experts, and will follow strict rules to deal with the problem.*
ADVANCED BEGINNER	*For an advanced beginner the situational aspects are important, there is some sensitivity to exceptions to the 'hard' rules of the novice. Maxims are used for guidance through the problem situation.*
COMPETENT	*A competent problem solver works in a radically different way. Elements in a situation are selected for special attention because of their relevance. A plan is developed to achieve the goals. This selection and choice can only be made on the basis of a much higher involvement in the problem situation than displayed by a novice or an advanced beginner. Problem solving at this level involves the seeking of opportunities. The process takes on a trial-and-error character, with some learning and reflection. A problem solver that goes on to be proficient immediately sees the most important issues and appropriate plan, and then reasons out what to do.*
EXPERT	*The expert responds to a specific situation intuitively, and performs the appropriate action straightaway. There is no problem solving and reasoning that can be distinguished at this level of working. This is a very comfortable level to be functioning on, and a lot of professionals do not progress beyond this point.*
MASTER	*The master sees the standard ways of working that experienced professionals use not as natural but as contingent. A master displays a deeper involvement into the professional field as a whole, dwelling on successes and failures. This attitude requires an acute sense of context, and openness to subtle cues.*
VISIONARY	*The visionary consciously strives to extend the domain of operation developing new ways of doing things, outcomes, definitions of the issues, opens new worlds and creates new domains. The visionary operates more on the margins of a domain, paying attention to other domains as well, and to anomalies and marginal practices that hold promises of a new vision of the domain.*

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Academic Design Management Conference dmi: ADMC

20th DMI: Academic Design Management Conference
Inflection Point: Design Research Meets Design Practice
Boston, USA, 22-29 July 2016

Towards a holistic framework of design competence.

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This article focuses on the development of a holistic competence framework that highlights the relationship between knowledge, attitude, skill and capability within the field of design management and design-led innovation. Whilst individual expertise in the aforementioned attributes are important to individual performance, it is argued that becoming an expert in design ultimately originates from a combination of these attributes and the ability to apply them in any given context.

The article derives a framework through a systematic review of the design competence literature, before applying this framework to a case study based on a postgraduate design project. The case study provides an insight into the competence held and developed by individuals at a postgraduate level multidisciplinary design-led innovation practice course, providing a foundation for future study in the area. The framework is capable of mapping the transition of competence from the novice designer to an expert who has mastered the ability to apply competence to any given context and as such offers a unique insight into design competence, given that current models primarily focus on education alone with little discussion of transition into design management, design-led innovation and its practice.

***Keywords**: Design competence; Design knowledge; Design skill, Design attitude, Holistic competence.*

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1.0 Introduction

Contemporary organisations are facing complex, open-ended challenges that require leaders to broaden their range of thinking in order to develop strategies capable of dealing with these problems (Stacey, Griffin, & Shaw, 2000). 'Multidisciplinary teams are becoming increasingly prevalent as their variety of knowledge, resources and perspectives is suggested to enhance the ability of the organisation to deal with such challenges' (Reuveni & Vashdi, 2015, p.678). Despite this, within multidisciplinary collaboration, the discipline of design can often be misunderstood by other disciplines due to the implicit and deeply held beliefs that are central to the nature of design knowledge; which is often intangible, yet provides designers with the capability to propose novel solutions to complex problem situations.

Studies seeking to understand the attributes of individual designers within the context of both multidisciplinary teams and organisational leadership vary in their approach to achieving an understanding, however many studies centre on the notion of competency development. Despite this, current studies within design research have struggled to arrive at a consistent definition of the term 'competency', with several studies viewing it purely as a basic set of design abilities. These abilities are often not specific to the field of design and as a result only offer a slight insight into the value that design can offer above other disciplines in relation to problem solving. This is particularly important for studies that are seeking to research design practice within organisations, where design can face difficulties in highlighting the value that it offers outside of traditional product creation (Conley, 2004).

The aim of this paper is to consider the types of competency framework that are suggested across design literature in order to arrive at a framework that is capable of offering an insight into the uniqueness of design within multidisciplinary contexts. The framework will then be applied to a multidisciplinary postgraduate education context, in which the students completed a project with industry clients in order to create innovative solutions to an existing complex problem situation. Through this, it is hoped that a suitable foundation for future research will be provided, in which it will be possible to explore in detail the attributes that underpin the work of successful design leaders.

The article is structured as follows: first, relevant literature is reviewed, discussing current models of design competence and exploring the need for further frameworks. Subsequently, a holistic competence framework is proposed and explained, outlining the individual areas in which designers possess attributes related to competence. Next the methodology is described in relation to outlining specific examples of competence that are related to the proposed framework within the context of a postgraduate innovation project. Finally, conclusions are explained, providing contributions to theory in addition to highlighting opportunities, limitations and recommendations for future research.

2.0 Design Competence

According to Berge et al., (2002) the term competency initially stemmed from a belief that clearly defined competencies would systematically ensure effective job performance within the context of an organisation. Many different definitions of competence have evolved from this starting point, resulting in a range of definitions and frameworks that have been derived within different fields; yet not all of these definitions are compatible and as such there is still much debate surrounding the nature of the term. Rychen and Saganik (2001) offer a broader definition of the term, stating that a competence is the ability to meet complex demands by drawing on and mobilising psychological resources in a particular context. An insight into the psychological resources required for competence can perhaps be found in the definition offered by the European Centre for the Development of Vocational Training (Cedefop, 2008), who state that a competence is not limited to cognitive elements (involving the use of theory concepts or tacit knowledge); it also encompasses functional aspects (involving technical skills) as well as interpersonal attributes (involving social or organisational skills and ethical values).

Similarly, within design research there are a variety of studies that tackle competency development, however there is little consensus towards a universal definition of the term. Subsequently, two contrasting schools of thought have emerged and have been termed 'the reductionist' and 'the holistic' view of design competence (Kovačević, 2008). The reductionist view is nothing other than a basic set of design abilities typically addressed

individually, whereas the holistic view sees design competence as a synergetic construct of generic human capacities (ibid).

2.1 The reductionist view of competence

The reductionist view is common within design management literature, with authors such as Hardin, Westcott and Berno (2014) using this approach to highlight the necessary competence that new designers need to develop in order to successfully transition into effective design managers in the future. Their proposed competency framework includes attributes such as: leadership, communication, collaboration, visualisation and storytelling. Røise et al. (2014), also adopt this viewpoint in an investigation into the competence of industrial designers. They create a taxonomy that includes teamwork, creativity, project management, and visualisation amongst others in order to create a map documenting common perceptions of design competencies. Whilst these attributes are no doubt important to design management, it can be argued that they meet Conley's (2004) criticism of many competence studies, in that they are generic and do not necessarily capture the essence of what designers really do.

The reductionist view is perhaps more appropriate to studies of education in disciplines where the focus is on a collection of knowledge that students need to recall in order to pass exams. In contrast, the focus within design education is on framing a collection of knowledge within a broader set of capacities that are also needed in order to deal with an increasingly complex set of problems. As a result, the holistic view of competence is perhaps more relevant to understanding the competence of design leaders, as it is capable of highlighting the broader set of competencies that are necessary in order to deal with the complexity of design problems.

2.2 The holistic view of competence

In contrast to the reductionist view, the holistic view sees competence as a mix of various attributes combined into a coherent framework. The aim of these frameworks are primarily centred around ensuring that a more complete model of professional development can be produced in comparison to the more simplistic reductionist models (Cheetham &

Chivers, 1996). Le Deist and Winterton (2005) suggest that generally, the notion of competence is being broadened to capture underlying knowledge and behaviours rather than simply functional competencies associated with specific occupations, however it appears that this transition is still occurring within the field of design.

Nelson and Stolterman (2012), propose a framework of competence within design learning that centres around four domains of design learning: design character, design thinking, design knowing and design action or praxis. It is suggested that these domains combine to form an axis of dichotomies that must be achieved in order for one to become a designer. They indicate that the responsibility in learning to be a designer is the challenge of maintaining this knowledge set over time by continually discarding and renewing content as necessary. It is suggested that the role of design education is to ensure that these domains are brought together at the right time, in the right proportion, in the right environment, managed by the right people in order to become an interconnected temporal whole, producing a competent design professional.

Horváth (2006) proposes a different framework centred around the concept that design competence is a synergetic construct of five generic capacities: capabilities, attitude, knowledge, skills and experiences. The key proposition to this framework is that equal emphasis must be placed on each capacity in order to develop well-rounded designers capable of applying this competence to a wide range of contexts. Whilst this framework goes some way towards creating a model for design competence, by the authors own admission the investigation was limited in scope and many more things need to be investigated in order to have a validated theory of comprehensive design competence development. In particular, the framework does not consider the difference between generic constituents of design competence and the specific needs of design tasks in relation to driving innovation within multidisciplinary teams.

Furthermore, both of the aforementioned examples of holistic competence frameworks revolve around design learning and education and do not consider the way in which a designer's competence is shaped outside of education, throughout various stages of expertise. This is also a prominent issue with the reductionist approach, highlighted by Miller and Moultrie (2013) who indicate that little is understood of the skills needed by

individuals who are responsible for leading design. It is this gap that this paper aims to address, building on the framework proposed by Horvárth (2006), in creating a framework that can be applied to education, but can also be applied to practice in order to map the differences between individuals in both contexts. It is expected that this would be of interest to both educators and practitioners of design, by highlighting the relationship between competencies across both domains.

3.0 Towards a holistic competence framework for design innovation

The previous sections have discussed the key differences between reductionist and holistic competency frameworks, however they highlight a lack of consensus towards a suitable framework in the field of design innovation. Holistic frameworks appear best suited to describing the competencies of design individuals as they contain many aspects that are discussed in the reductionist frameworks, yet offer further possibilities in explaining the uniqueness of design in comparison to other disciplines. In order to arrive at a consensus regarding the components of a competency framework, Appendix A outlines an in depth view of existing frameworks including the various components that constitute the framework as well as the context in which each framework was derived. Some of the frameworks are derived from a professional development context, which are seen to offer an insight into the general competencies that are needed by people in the workplace, whereas other frameworks are more specific to the design discipline, exploring the factors that lead to the success of individuals in the field. Holistic frameworks have the potential to bridge the gap in existing theory within design research, however they appear more common within general professional development literature as opposed to design research.

From this review, it is proposed that a holistic framework comprised of knowledge, skill, attitude and capability demonstrates the potential to provide an insight into the competency of designers, when considered alongside the level of experience that a person has in each aspect. Each of these aspects are seen to be mutually interactive and as a result, they are difficult to separate as seen in typical reductionist frameworks. Appendix B visualises the relationship between these specific aspects of competency,

which will be further described in stages throughout the remainder of section 3.

3.1 Knowledge

Like competence, the term knowledge often holds multiple connotations and interpretations (Augier & Vendelø, 1991). The way in which knowledge is defined is directly related to the way in which it is both developed through education and managed within organisations. Knowledge can be defined as data that is collected, processed and/or elaborated in the past and integrated into memory, which then plays an important role in problem solving (Visser, 1995). Cross (2006) summarised design knowledge as comprising abilities of resolving ill-defined problems, adopting solution focused strategies, employing abductive reasoning or appositional thinking and using non-verbal modelling media.

Within design research, there have been several attempts to classify design knowledge with many of these attempts typically pairing contrasting types of knowledge (Biggam, 2003; BonJour, 1985; Grayling, 2003; Neuweg, 2002; Rodgers & Clarkson, 1998). Niedderer (2007) conducts an in depth review into knowledge types and concludes that the most important knowledge pairs when conducting design research are the two pairs of tacit and explicit knowledge and propositional and non-propositional knowledge. Whilst other knowledge types can offer important distinctions within their fields, to discuss every term of knowledge in detail is beyond the scope of this work. Subsequently, within this work, the focus will remain on the pairs of tacit and explicit knowledge and propositional and non-propositional knowledge, which appear to be the most important pairs within design research.

Tacit knowledge is commonly defined as knowing more than we can tell (Polanyi, 1958). It is impossible to articulate and is intuitive, forming part of an individual's cognitive thought and perception (Suppiah & Sandhu, 2011). Subsequently, tacit knowledge is difficult to share, with the results often being slow, costly and uncertain (Wang, Ashleigh, & Meyer, 2006). Despite this, Davenport and Pruask (1998) outline that the value of sharing tacit knowledge is so great that it can be critical to an organisation's success. With regards to an organisation's innovation capabilities, Nonaka and

Takeuchi (1995) identify that successful innovation within organisations directly stems from the mobilisation and conversion of tacit knowledge, therefore the tacit knowledge held by design leaders will form a critical part of their overall leadership competence.

Contrastingly, explicit knowledge is often referred to as codified in that it can be expressed using formal language. It is organised 'according to a clear and known system and can therefore be written down or transmitted verbally with little or no interpretation on behalf of the sender or receiver' (Nylund & Raelin, 2015. p.534). Teece (1977) indicates that within organisations, explicit knowledge is typically transferred through manuals, reports, user interfaces and guidebooks. Generally, explicit knowledge with regards to innovation capacities is less useful in providing organisations with a competitive advantage, as explicit knowledge tends to be easily available to competitors and therefore much easier to replicate than tacit knowledge (Cavusgil, Calantone, & Zhao, 2003); however it is still an important feature within the innovation process, with Smith (2001) indicating that organisations that are capable of recognising a wealth of tacit and explicit knowledge and utilising it to achieve goals have a major competitive advantage. Subsequently, it is also important to consider the explicit knowledge held by design leaders, due to its relationship with the tacit knowledge that they possess.

Whilst the tacit and explicit knowledge pair is formed to distinguish knowledge by the characteristic of communication, propositional and non-propositional knowledge is a distinction concerning the nature of knowledge. Propositional knowledge is knowledge that can be expressed in declarative sentences and is knowledge of something rather than knowledge of how to do something (Gemma, 2014). For example, a person being able to recall the contents of a textbook would count as propositional knowledge, however they may not be able to apply this knowledge to solve a problem based on the contents of the textbook. Non-propositional knowledge contrasts this, in that it is acquired by directly carrying out a task.

With regards to design leadership, propositional knowledge relates to the education that people receive in that it is acquired through conservative forms of learning. Non-propositional knowledge is perhaps more relevant in that it relates to the experiences that design leaders have and their ability to apply their knowledge to problem solving. Lawson and Dorst (2009) echo

this, finding that knowledge within design tends to be more 'episodic' than 'semantic'. Episodic memories include: events in our lives, things that we have seen and done and places that we have been. Subsequently episodic knowledge is the type of knowledge that is largely generated through a person's experiences. Osland *et al.* (2001) refer to this process as experiential learning and builds on Kolb's learning cycle (1985) to explain that experiential learning typically occurs through four phases: concrete experience, reflective observation, abstract conceptualisation and active experimentation. The application of experiential knowledge to problem solving within the field of design ensures that more attention is given to finding the right problems to work on, problems are adequately defined, better solutions are found and a more effective implementation process is followed. Subsequently knowledge is an important attribute when solving design problems, however knowledge alone is not enough to ensure that a person is in a position to utilise the knowledge that they possess; according to Kirschner *et al.* (1997), the person in question also needs the necessary skill, which will be discussed further in the next section.

3.2 Skill

Singley and Anderson (1989, p.2) characterise skill as 'the application of knowledge to a task', which is closely related to non-propositional knowledge, where the user of cognitive skill is carrying out a higher order process with any knowledge gained. Unlike knowledge, skill is difficult to acquire in a short space of time, therefore there is an extensive variance between the skill set of a novice designer and the skill set of an expert. Skill sets often require extensive practice to master, a view expressed by Gladwell (2008) who discusses several psychology studies that highlight that the practice of a skill for a duration of time (approximately ten thousand hours) ultimately leads to the level of mastery associated with being a world-expert of that skill. This is echoed by Posner and Keele (1973) and Sennett (2008) who argue that skills within craftsmanship (inline with the intuitive approach of design) are hardly ever developed in a single attempt. Sennett (ibid.) claims that skills provide the foundation of a craft, with the novice being problem attuned transitioning to an expert who is capable of utilising skills by fully feeling and deeply thinking about what they are doing. Skills are therefore an important construct within any competency

framework, in that they are essential for the application of knowledge to a context, yet they are also extremely dependent on experience and practice.

3.3 Capabilities

Design capabilities are general personal qualities that are needed by people in order to develop design competence. They are natural capacities that allow people to act as designers and they can take many forms, such as: intelligence, imagination and creativeness. Reynolds and Snell (1988) identify these capabilities as being both generic and high-level, proving to be crucially important in both the acquisition and reinforcement of skills. Yeung and Ready (1995) advocate capabilities as one of the central components of competence within organisational leadership, suggesting that a strong set of capabilities is critical for the leadership of global corporations in which organisational structures, processes and systems struggle to cope with complex business environments. Consequently, well-developed capabilities provide a sound base for the development of the other areas of competence and are therefore important in the development of strategic level leaders.

The development of capability is fundamentally different to knowledge and skills, in that it is much more difficult to be taught. Brown and McCartney (1995) express that people are capable of acquiring knowledge and task specific skills through on the job training or participation in formal education, but the efficient application of these attributes is dependent on capabilities which cannot be so easily taught. This poses a challenge to educators and designers seeking to improve the capability aspect of competence, as it is a complex and difficult area to address directly. Horváth (2006) suggests that design capabilities can be developed in a similar manner to other innate physical and mental human capabilities, however this process typically requires many years of difficult focused learning and practicing. The time taken to develop capabilities suggests that they are a key differentiator between people of varying levels of experience, with experts likely to be in a position where they have had years to develop these capabilities, as opposed to a student fresh out of university who has not spent an equal amount of time with a focus on learning and practice.

3.4 Attitude

A design attitude is a unique mind-set and approach to problem solving that allows designers to shape inspiring and energising designs for products, services and processes that are both profitable and humanly satisfying (Boland & Collopy, 2004). A decision attitude contrasts the design attitude, and is prominent within management education. It assumes that it is easy to derive solutions to a problem, but it is difficult to make the correct choice among them. On the other hand, the design attitude assumes that it is difficult to develop a good solution or alternative to a problem, however, when you design a great solution, the decision about which alternative to select becomes trivial. The design attitude appreciates that the cost of not conceiving a better course of action is often much higher than making the 'wrong' choice among them.

Key elements of a design attitude are questioning of basic assumptions and a resolve to leave the world a better place (Carlopio, 2010). Designers relish the lack of predetermined outcomes and they tend to approach new projects with a desire to experiment with materials, technologies and methods and to do something differently and better than ever before. To do this, designers must work creatively within the established boundaries of a project and each project must be approached with a desire to experiment and do something differently and better than ever before (ibid). Michlewski (2008) suggests that attitudes will likely differ significantly between professionals from different fields, such as: product design, accounting, operations, management and marketing. Subsequently, a design attitude is an entity that is capable of differentiating design from other disciplines, meaning that it should be a prominent feature in any competence framework.

3.5 Experience

It is important for any competency framework to consider the way in which competencies are developed through both learning and practice, over time. To do this, it is worthwhile adopting a model of experience that is capable of documenting the stages of skill acquisition that people follow. Perhaps the most extensively utilised model of skill acquisition is provided by Dreyfus and Dreyfus (1986) who suggest that there are five stages in the

human skill acquisition process, with an individual transitioning from novice to expert with increasing exposure to skilful practice (visualised in appendix C).

Criticisms of the Dreyfus model are offered by Lawson and Dorst (2009) who highlight that design is an activity that is not restricted to people that have undergone formal training, or on occasion even realise that they are designing. Despite this criticism, the Dreyfus model appears to be a useful model in explaining a designer's development as their experience increases. Dorst and Reymen (2004) indicate that the Dreyfus model takes the development of skills as a starting point for a model of learning and expertise development, which is closely linked to the way in which design competence is developed through education and practice.

3.6 Summary

To summarise, the framework highlights that skill, knowledge, attitude and capability are interconnected capacities that combine to explain competence within design. Previous frameworks that adopt the reductionist approach do not provide a full picture of design competence, whereas holistic approaches are better positioned to do this. The framework derived in this paper suggests that as people acquire experience through practice, their competence increases. Ultimately people who are experts in the field have the ability to take their competence and apply this to a problem in any given context. Next the framework is applied to design education, utilising a case study of a postgraduate design project.

4. Methodology

The methodology for this research utilised qualitative methods in the form of a workshop to determine the learning that occurred through a postgraduate design project. The chosen design project centred on a social innovation issue and lasted three weeks from the initial project briefing to the delivery of concepts. Fourteen students from a multidisciplinary design postgraduate programme at a UK University took part in this research, having completed this project at an earlier date. Participants in the

workshop worked in the same teams that they were in for the project for the first three activities and were then asked to answer questions individually for the final two activities.

The workshop commenced with the students documenting a timeline of the project to provide a template for the workshop questions. Wording of the workshop questions was critically important in gaining as full a response as possible without offering solutions or leading the students in any way. In determining the skills and capabilities that were used throughout the project, students were asked to use the timeline to write down the corresponding skills that they felt they used at each stage of the project. Students were not told about the distinction between skills and capabilities at this stage, with the distinction being drawn by the researcher in the analysis of the provided data. This was appropriate as it ensured that students were focused on the output of the question, as opposed to the wording of two similar questions. Students were then asked to rank the skills that they improved most throughout the project, to determine which skills were present before the project and which were specifically developed throughout the project.

In order to determine the knowledge utilised throughout the project, the students were asked to choose three key decisions that they made throughout the project and then explain the knowledge that underpinned these choices. This allowed them to ground the notion of knowledge within a context that was easier for them to understand, instead of asking them to explain the knowledge that they drew from throughout the project. Finally, in order to determine attitude, participants were asked about the aspects of the projects that they found stimulating and the aspects that they found irritating. This was derived from Michlewski's work (2008), which focuses on design attitude, with the expectation that participants who had a design attitude would find similar aspects of the project engaging.

Using Benner's (2004) evaluation of the Dreyfus model of skill acquisition, the participants as postgraduate students are considered to be transitioning between the stages of advanced beginner and competent. Consequently the results outlined in the following discussion relate directly to design competence at that particular level of experience. Further study is required to apply the framework to the remaining levels of experience in

order to fully understand the development of competence from education into practice into mastery of the subject.

5.0 Discussion

The following section will discuss the findings of the workshop in relation to the framework categories.

5.1 Knowledge

Several of the decisions made during the project were underpinned by the knowledge of outside 'experts' who provided students with feedback of their initial concepts. Experts varied from tutors to industry contacts and often had a large influence on the decisions that students made. It is expected that this is something unique to people who aren't yet proficient in a craft, in that they are recognising the knowledge of people with more expertise and using it as the basis of crucial decisions. It is likely that people proficient in using design tools for problem solving would hold the experience necessary to make most decisions without seeking the knowledge of others to underpin choices made. Experts in particular would not rely on the knowledge of others in this manner. Consequently this could be unique to teaching environments, where people are in the process of learning the skills that they need to solve design problems in a wide range of contexts.

The students involved in the project also relied on experiential knowledge derived through previous projects, particularly in relation to research methods that were adopted. The students had awareness from previous projects of the benefits of a survey methodology in relation to the type of data that was needed for this particular project as well as the timescale being compatible with the timeframe of the project. They were able to draw from past experience to apply methods in a new context, which is an incredibly important aspect of design knowledge.

Finally, one group in particular recognised that they were having difficulties in the idea generation phase of the project, stating that they felt

'stuck' in the process and that they found it difficult to progress. Through working on other projects, they were able to establish that they were having difficulties quite early on in the process and as a result were able to seek out alternative strategies to help them through the problem that they faced in creating new concepts. Through experience of delivering projects the group were able to identify that part of their process was not working as fluidly as it had in the past and therefore applied this knowledge to the problem at hand.

5.2 Skill

The design specific skills utilised by the students in this particular project revolved around several categories: communication, bringing ideas to life, concept development, problem framing and user centred approach. Bringing ideas to life includes skills such as prototyping (3D, rapid), sketching and visual communications. These skills typically revolve around the development of concepts through a medium in which tactile learners are more confident in expressing their ideas. They are extremely common tools utilised within design, however they are not often seen in any disciplines outside of the wider category of design.

In terms of skill improvement over the course of the project, communication between multidisciplinary team members was highlighted as one of the major changes. Sennett (2012) describes this communication process as dialogic, looking at new situations in a problem-finding manner. This skill was identified as being particularly important in the initial stages of the project, in exploring and framing the problem. This type of exchange is perhaps specific to design in which problem finding is core to the discipline and a specific aspect of team communication. Innes (2007) suggests that dialogic communication is also central in the construction of experience and useful knowledge, making it an important tool in connecting skills to other aspects of this framework.

Developing a user centred approach to problem solving was also highlighted as one of the key areas of improvement throughout the project. This is both core to the discipline of design and unique to the discipline, making it an important aspect developed through the project. Students used

a variety of skills within this area, including empathy, customer profiling and segmentation of potential markets.

5.3 Capability

The capabilities frequently utilised throughout the project centred on the themes of project management, people management and justifying decisions in relation to specific criteria (e.g. stakeholder analysis and making a business case). Capabilities focused around working with others were also featured prominently throughout the workshop, with capabilities such as managing client expectations, networking, negotiation and patience appearing to be relevant to several stages of the project. Students had to manage the relationship with clients from the beginning of the project and utilised methods such as negotiation in dealing with this. These capabilities were therefore crucial in the execution of the project, however they are not especially unique to the discipline of design. Despite this, whilst these are not design specific capacities, they are extremely important in reinforcing the design specific skills outlined in the previous section.

5.4 Attitude

The design attitude revolves around the way in which designers approach and feel about problems. The students who engaged with this particular project found the brief itself to be stimulating, allowing for the creation of a wide range of concepts with the students being given "complete creative freedom" over the process. Stimulus was also found in the presenting of ideas and concepts to clients at the end of the project. This aligns with Boland and Collopy's (2004) expression that when people with a design attitude believe that they have created a truly innovative solution to a problem, the decisions to implement that idea become incredibly straight forward.

A design attitude was prominent amongst all of the students that took part within the research, particularly amongst those who had formal design backgrounds as opposed to other multidisciplinary teammates. This suggests that the development of a design attitude is something that can occur quite early on in the skill acquisition process. Viewing problems in this manner is

something that is likely to be common between the postgraduates that took part in this particular project and any expert designers that approached the same project.

6.0 Conclusion

To summarise, there are two key schools of thought within the design competence literature, the reductionist and holistic view. Reductionist frameworks view competence as a basic set of design abilities and are often not detailed enough to give a comprehensive view of design competence. The holistic view aims to correct this in viewing competence as a combination of various human capacities working together in synergy. The framework proposed in this paper considers competence to be made up of skill, knowledge, attitude and capability. The competence held by a designer is dependent on the level of experience that they have in each of these capacities.

Next, the paper provided a picture of design competence through the lens of a postgraduate design-led innovation project carried out at a UK university. It was found that the students relied on the knowledge of 'experts' in making their decisions, as well as making decisions based on experiences from similar projects carried out in the past. Design specific skills were prominent in the areas of communication, bringing to life, concept development, problem framing and a user centred approach. Particular improvements were seen in the development of a communication style that was problem finding. General capabilities were prominent in the interactions of people, with the managing client expectations found to be one of the key areas of improvement. It was also found that at this level of experience, people were capable of having a design attitude in their approach to problem solving. It is likely that this approach is common from an early level of skill acquisition.

Framing design competence through a holistic approach has implications for the way in which design is taught, practiced and managed. Design management education must look at the different aspects of competence to ensure that students are acquiring the broad range of competence necessary to transition into successful practice, rather than primarily

focusing on skill development. Meanwhile, design managers may also find this framework useful in facilitating reflection, in an attempt to fuel the personal development of themselves and others. The suggested competencies all play a role in the practices of innovation, therefore a deeper understanding of competency will allow better management of the people involved within innovation processes, particularly when it comes to making decisions based upon the strengths and weaknesses of a team. To further enhance these findings, more extensive research is needed to align the competencies developed within this case study to other postgraduate programmes in order to build a more comprehensive picture of design competence.

There is room for future research into the competencies held by those already in practice, particularly those considered to be experts in their field. Again, this will provide a more complete picture of competence across both education and practice. It is suggested that the framework discussed in this paper will prove to be a suitable template for this research. Furthermore, the use of workshops to facilitate reflection in this instance proved particularly useful in creating a discussion surrounding the explicit knowledge that the participants had developed throughout the project, however the primary limitation of the approach is that it is impossible to uncover much in the area of tacit knowledge. It is suggested that a workshop technique be applied alongside a method such as repertory grid interviews (Gribbin, Young and Aftab, 2016) in order to provide a more complete insight into the knowledge that is utilised and developed throughout project based activities.

References

Angeles, J., Britton, R., Chang, L., Charron, F., Gregson, P., Gu, P., Lawrence, P., Stiver, W., Strong, D. & Stuart, P. 2011. The engineering design competency. *Proceedings of the Canadian Engineering Education Association*.

Augier, M. & Vendelø, M. T. 1991. Networks, cognition and management of tacit knowledge. *Journal of Knowledge Management,* 3**,** 252-261.

Benner, P. 2004. Using the Dreyfus model of skill acquisition to describe and interpret skill acquisition and clinical judgment in nursing practice and education. *Bulletin of science, technology & society,* 24**,** 188-199.

Berge, Z., Verneil, M. D., Berge, N., Davis, L. & Smith, D. 2002. The increasing scope of training and development competency. *Benchmarking: An International Journal,* 9**,** 43-61.

Biggam, J. 2003. Identifying and capturing knowledge for website usage: a platform for progress. *International Journal of Electronic Business,* 1**,** 225-236.

Boland, R. & Collopy, F. (eds.) 2004. *Managing as Designing,* Stanford, Calafornia: Stanford University Press.

Bonjour, L. 1985. The structure of empirical knowledge, Cambridge Univ Press.

Brown, R. B. & Mccartney, S. 1995. Competence is not enough: meta-competence and accounting education. *Accounting Education,* 4**,** 43-53.

Carlopio, J. 2010. Strategy by design. New York: Palgrave MacMillan.

Cavusgil, S. T., Calantone, R. J. & Zhao, Y. 2003. Tacit knowledge transfer and firm innovation capability. *Journal of Business & Industrial Marketing,* 18**,** 6-21.

Cedefop 2008. Terminology of European education and training policy: A selection of 100 key terms. Luxembourg: Office for Official Publications of the European Communities.

Cheetham, G. & Chivers, G. 1996. Towards a holistic model of professional competence. *Journal of European industrial training,* 20**,** 20-30.

Chyung, S. Y. S., Donald; Cox, David 2006. Building a competency based curriculum architecture to educate 21st century business practicioners. *Journal of Education for Business,* 81.

Conley, C. 2004. Leveraging design's core competencies. *Design Management Review,* 15**,** 45-51.

Cross, N. 2006. Designerly ways of knowing, London, UK, Springer.

Davenport, T. & Prusak, L. 1998. Working knowledge: How organisations manage what they know, Boston, MA, Harvard Business School Press.

Dorst, K. & Reymen, I. 2004. Levels of expertise in design education. In: Lloyd, P., Roozenberg, N., McMahon, C. & Brodhurst, L. (eds.) 2nd International Engineering and Product Design Education Conference (IEPDE). Delft, The Netherlands.

Dreyfus, H. & Dreyfus, S. 1986. Mind over machine: The power of human intuition and expertise in the era of the computer, New York, USA, The Free Press.

Gemma, W. 2014. *The 6 types of knowledge: From a priori to procedural* [Online]. Available: https://blog.udemy.com/types-of-knowledge/ [Accessed 10th September 2015].

Gladwell, M. 2008. Outliers: The story of success, London: England, Penguin Books.

Godbout, A. J. 2000. Managing core competencies: the impact of knowledge management on human resources practices in leading-edge organizations. *Knowledge and Process Management,* 7**,** 76-86.

Grayling, A. 2003. Epistemology. *In:* Bunnin, N. & Tsui-James, E. (eds.) *The blackwell companion to philosophy.* Oxford, United Kingdom: Blackwell Publishing.

Gribbin, J., Young, R., & Aftab, M. 2016. Double-loop reflective practice as an approach to understanding knowledge and experience. *2016 Design Research Society 50th Anniversary Conference*.

Hardin, D., Westcott, M. & Berno, T. 2014. Redesigning graduate education. *Design Management Review,* 25**,** 12-21.

Ho, C. H., Mingju 2015. The study on the competence criteria on digital content designs for digital publishing editors. *In:* Ouyang, Y. L. Y., Min Xu; Ouyang, Yujie (ed.) *China academic conference on printing and advanced graphic communications, packaging and technology materials.* Singapore: Springer.

Horváth, I. 2006. Desgn competence development in an academic virtual enterprise. International design engineering technical conferences and computers information in engineering conference. Philadelphia, Pennsylvania USA.

Hummels, C. V., Diana 2009. Eindhoven designs: Developing the competence of designing intelligent systems.: Eindhoven University of Technology.

Innes, R. B. 2007. Dialogic communication in collaborative problem solving groups. *International Journal for the Scholarship of Teaching and Learning,* 1**,** 4.

Kirschner, P., Van Vilsteren, P., Hummel, H. & Wigman, M. 1997. The design of a study environment for acquiring academic and professional competence. *Studies in Higher Education,* 22**,** 151-171.

Kolb, D. 1985. Learning styles inventory. *The Power of the 2 2 Matrix***,** 267.

Kovačević, A. Competence development in an international product design course. DS 48: Proceedings DESIGN 2008, the 10th International Design Conference, Dubrovnik, Croatia, 2008.

Lawson, B. & Dorst, K. 2009. *Design expertise,* Jordan Hill, Oxford, Elsevier.

Le Deist, F. D. & Winterton, J. 2005. What is competence? *Human resource development international,* 8**,** 27-46.

Michlewski, K. 2008. Uncovering design attitude: Inside the culture of designers. *Organization Studies,* 29**,** 373-392.

Miller, K. & Moultrie, J. 2013a. Delineating design leaders: A framework of design management roles in fashion retail. *Creativity & Innovation Management,* 22**,** 161-176.

Miller, K. & Moultrie, J. 2013b. Understanding the Skills of Design Leaders. *Design Management Journal,* 8**,** 35-51.

Nelson, H. & Stolterman, E. 2012. *The design way,* Massachusetts, USA, MIT Press.

Neuweg, G. H. 2002. On Knowing and Learning: Lessons from Michael Polanyi and Gilbert Ryle. *Appraisal***,** 41-48.

Niedderer, K. 2007. Mapping the meaning of knowledge in design research. *Design Research Quarterly*.

Nonaka, I. & Takeuchi, H. 1995. *The knowledge creating company,* Oxford, United Kingdom, Oxford University Press.

Nylund, P. A. & Raelin, J. D. 2015. When feelings obscure reason: The impact of leaders' explicit and emotional knowledge transfer on shareholder reactions. *The Leadership Quarterly,* 26**,** 532-542.

Osland, J., Kolb, D. & Rubin, I. 2001. Organizational behaviour: An experiential approach, Upper Saddle River, New Jersey, Prentice-Hall, Inc.

Polanyi, M. 1958. Personal knowledge: Towards a post-critical philosophy, Chicago, University of Chicago Press.

Posner, M. & Keele, S. 1973. Skill learning. *In:* TRAVERS, R. (ed.) *Second handbook of research on teaching.* Chicago, Illinois: Rand McNally.

Reuveni, Y. & Vashdi, D. R. 2015. Innovation in multidisciplinary teams: The moderating role of transformational leadership in the relationship between professional heterogeneity and shared mental models. *European Journal of Work and Organizational Psychology,* 24**,** 678-692.

Reynolds, M. & Snell, R. 1988. Contribution to development of management competence. Sheffield: Manpower Services Commission.

Rodgers, P. A. & Clarkson, J. P. 1998. An Investigation and Review of the Knowledge Needs of Designers in SMEs. *The Design Journal,* 1**,** 16-29.

Røise, Ø., Edeholt, H., Morrison, A., Bjørkli, C. A. & Hoff, T. 2014. What we talk about when we talk about design. *FORMakademisk,* 7**,** 1-17.

Rolinska, A. 2011. *On Dreyfus' model of acquisition* [Online]. Available: http://idel11.pbworks.com/w/page/36248121/Dialogue%204 [Accessed 17th April 2016].

Rychen, D. & Saganik, L. 2001. Key competencies for a successful life and a well functioning society, Washington, USA, Hogrefe & Huber Publishers.

Sennett, R. 2008. *The Craftsman,* London, England, Penguin Books.

Singley, M. K. & Anderson, J. R. 1989. *The transfer of cognitive skill*, Harvard University Press.

Smith, E. A. 2001. The role of tacit and explicit knowledge in the workplace. *Journal of knowledge Management,* 5**,** 311-321.

Spencer, L. S., S 1993. *Competence at work,* New York, USA, Wiley.

Stacey, R. D., Griffin, D. & Shaw, P. 2000. Complexity and management: fad or radical challenge to systems thinking?, Psychology Press.

Statistics, N. C. F. E. 2002. Defining and assessing learning: Exploring competency based initiatives.

Suppiah, V. & Sandhu, M. S. 2011. Organisational culture's influence on tacit knowledge-sharing behaviour. *Journal of Knowledge Management,* 15, 462-477.

Teece, D. J. 1977. Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-How. *The Economic Journal,* 87, 242-261.

Visser, W. 1995. Use of episodic knowledge and information in design problem solving. *Design Studies,* 16, 171-187.

Wang, J.-K., Ashleigh, M. & Meyer, E. 2006. Knowledge sharing and team trustworthiness: it's all about social ties! *Knowledge Management Research & Practice,* 4, 175-186.

Yeung, A. K. & Ready, D. A. 1995. Developing leadership capabilities of global corporations: A comparative study in eight nations. *Human Resource Management,* 34, 529-547.

Appendix A

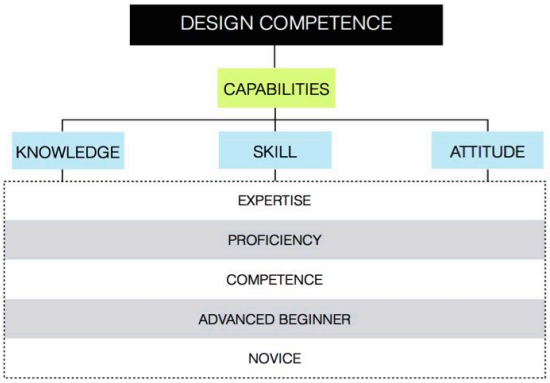
Reference	Type of framework	Context/field	Components
Ho and Hsu, 2015.	Reductionist	Digital content creation.	Layout design, understanding of user-interface principles, integration of different publishing formats and specifications, use of various editing software to create layouts, use of animation to create special effect images, utilising storyboarding techniques, conducting film editing.
Hardin, Westcott and Berno, 2014.	Reductionist	Graduate education for design management/leadership.	Leadership, self-awareness, collaboration, entrepreneurial/innovative attitude, communication, facilitation, visualisation, teaching, storytelling, maker mentality, culture making.
Røise *et al.*, 2014.	Reductionist	The professional competencies of industrial designers.	Teamwork, creativity, specific design methods, users, market, project management, aesthetics, holistic design approaches and methods, visualisation, technology, functionality, use, context, ecology.
Cheetham and Chivers, 1996.	Holistic	Professional education and development.	Knowledge/cognitive competence, Functional competence, personal or behavioural competence, values/ethical competence, meta-competencies.

Le Deist and Winterton, 2005.	Holistic	Training and development initiatives.	Cognitive competence, meta-competence, functional competence, social competence.
Nelson and Stolterman, 2012.	Holistic	Design practice and learning.	Design character, design thinking, design knowing, design action or praxis.
Horváth, 2006.	Holistic	Design practice	Capabilities, attitude, knowledge, skills, experiences.
Hummels and Vinke, 2009.	Holistic	TU/e industrial design competencies within education	Continuous learning, descriptive and mathematical modelling, integrating technology, ideas and concepts, form and senses, user focus and perspective, social cultural awareness, designing business processes, design and research processes, teamwork and communication. Under the banner of meta-competencies, knowledge, attitudes, skills, traits and characteristics.
Miller and Moultrie, 2013a.	Reductionist	Fashion management	Envisioning, designing, understanding, communicating, empowering, driving, planning, selecting, challenging, coordinating, optimising, directing, integrating, protecting, evaluating.

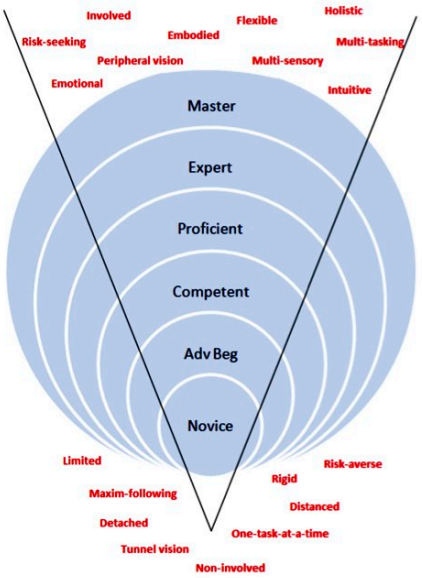
Miller and Moultrie, 2013b.	Reductionist	Design leaders	Cognitive skills, interpersonal skills, business skills, strategic skills.
Conley, 2004.	Reductionist	Design within business enterprise	Understanding the context of a design problem and framing it in an insightful way, working at a level of abstraction, visualising solutions, simultaneous creation and evaluation of solutions, maintain value as pieces are integrated into a whole, the ability to establish purposeful relationships among elements of a solution between the solution and its context, the ability to use form to embody ideas and communicate their value.
Spencer and Spencer, 1993.	Holistic	Human competence	Know-how task skills, transferable skills/ abilities, values, standards, etiquette, judgement, motives, work ethics, enthusiasm, self-image.
Godbout, 2000.	Reductionist	Knowledge management within human resources practices	Performance orientation, team leadership, conceptual skills, analytical skills, self-assurance, initiative.
Angeles *et al.*, 2011.	Holistic	Design engineering	Established skills for design engineers, attitudes towards design engineering, specific knowledge in a professional environment, knowledge of procedures.

International Board of Standards for Training and Performance Instruction, 2005; in: Chyung *et al.*, 2006.	Holistic	Professional development	Knowledge, skill, attitude.
National Centre for Education Statistics, 2002.	Holistic	Education/competency based learning	The combination of skills, knowledge and attitude to perform a specific task.

Appendix B


DESIGN COMPETENCE
CAPABILITIES
KNOWLEDGE
SKILL
ATTITUDE
EXPERTISE
PROFICIENCY
COMPETENCE
ADVANCED BEGINNER
NOVICE

Appendix C



(Rolinska, 2011)

Strategic Design Research Journal, 10(2): 126-133 May-August 2017
Unisinos – doi: 10.4013/sdrj.2017.102.05

Understanding the dynamics of attitudes within a design and business focused collaboration

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Abstract
This paper aims to advance understanding about design's unique contributions within collaborations between the disciplines of design and business. Collaboration between design and business functions is increasingly utilised as organisations seek to capitalise on a variety of knowledge and perspectives during the innovation process. Despite this increasing prevalence, the discipline of design can often be misunderstood by other disciplines within this particular interdisciplinary scenario due to the implicit knowledge that is central to the nature of design, which is often intangible and tacit in nature, yet provides designers with the capability to propose novel solutions to complex problem situations. This paper takes a deeper look at design attitude, which has previously been suggested to be one of the differentiators between design and other disciplines. The paper reflects on the results of a case study focusing on a collaboration between a multinational consumer goods company and a team of postgraduate students working out of a UK University. Data was obtained through observation, a reflective workshop and repertory grid based interviews. The originality of the paper lies in the way in which it categorises attitudes of different disciplines, in order to capture aspects of the design attitude that appear to be both unique and difficult for business focused people to adopt.

Keywords: design attitude, multidisciplinary innovation, design knowledge.

Introduction

Contemporary organisations face complex, open-ended challenges that require leaders to broaden their range of thinking in order to develop strategies capable of dealing with these problems (Stacey *et al.*, 2000). In dealing with these challenges, organisations are frequently turning to multidisciplinary collaborations due to the broader depths of knowledge, resources and perspectives that are capable of enhancing the quality of an organisation's innovation outputs (Reuveni and Vashdi, 2015). Design is often at the core of this process, with organisations looking to implement design thinking methods in order to deal with the challenges offered by open, complex problem situations (Dorst, 2011). Subsequently, design-driven innovation has gained traction within organisational processes, specifically the way in which organisations strive to focus on the radical innovation of meanings as opposed to technology-push or market-pull strategies, which are more traditional modes of innovation (Verganti, 2009). As a result, design thinking can now be viewed as the application of design methods by multidisciplinary teams to a broad range of innovation challenges (Seidel and Fixson, 2013).

Although design can be a driver of innovation within interdisciplinary collaboration, the relationship between design and other disciplines within these types of collaborations is often scrutinised, particularly due to the importance that multidisciplinary collaboration can play in improving the competitiveness of organisations (Baregheh *et al.*, 2009). The paper will begin with a discussion of this literature within the context of the relationship between design thinking and business. Next, a summary of design attitude literature will be provided, followed by a description of the research process of the study. The paper will then outline key propositions that are made within the design attitude literature before discussing evidence of these propositions that was observed within the context of a collaborative project where design had to work closely with business and marketing. The wider implications of these findings to both research and practice are then discussed alongside the associated limitations of the research.

The relationship between design and business

Within the context of organisations, design thinking is essentially a human-centred process that emphasises observation, collaboration, fast learning, visualisation of ideas, rapid concept prototyping and concurrent business analysis which ultimately influences innovation and strategy (Lockwood, 2009). Subsequently, design thinking is a way of applying a designer's methods to problem solving, no matter what the problem is. The term design thinking can be traced back to the work of Simon (1955); however it is arguably the writing of Brown (2008) who popularised the term within the context of the management field. Brown (2008) suggested that design thinking is capable of leading to innovation that goes beyond aesthetics and as a result, creates ideas that better meet consumer needs and desires. Consequently, it is theorised that thinking like

a designer can transform the way organisations develop products, services, processes and strategies; which are capable of creating new forms of value to organisations.

Martin (2009) highlights that organisations best equipped to develop design thinking into a competitive advantage are those that have the capabilities to balance the exploration of new knowledge (innovation) and the exploration of existing knowledge (efficiency). On the whole, Martin (2009) indicates that there has been a surge in organisations seeking to implement design thinking methods, however design-thinking organisations remain a small minority. It is suggested that typically, the larger a company, the less likely they are to consider design thinking methods because of pressure from stakeholders who value reliability over validity. More recently, however, Kolko (2015) finds that a shift towards design thinking is occurring within larger organisations. This shift is focused on applying the principles of design to the way in which people work to create a design-centric culture within an organisation, which removes design from its historical association with aesthetics and craft and instead elevates the role of design towards imparting a set of principles to all people who help bring ideas to life. This aligns with Brown (2009) who finds that larger companies are better positioned to drive innovation from a consumer-centred perspective that allows them to exploit assets that they already possess: a larger customer base, recognised and trusted brands, experienced customer service and support systems and wide distribution and supply chains.

Using design as a driver of innovation in this way aligns with Verganti's (2009) theory of design driven innovation, which indicates that organisations with strong innovation capabilities focus on the radical innovation of meanings, as opposed to technology push or market pull strategies. This theory postulates that people invest in the meanings behind products as much as they invest in the products themselves. Similarly, design plays an important role in incremental product innovation within organisations. This refers to the small changes in a product or service that help to improve performance, lower costs and enhance desirability to customers (Norman and Verganti, 2014). Most successful products undergo this process, which makes it a process just as important as radical innovation. It is an area in which the core of business operates and often most revenues are generated.

Aftab (2013) investigates design-driven innovation within the context of strategic level leadership and finds that in order for an organisation to develop propositions through design-driven innovation, the design function must be given equal influence alongside other core organisational functions as design cannot lead an organisation on its own. Consequently, in order for design to share leadership responsibilities with other disciplines, the organisation must recognise the impact that design can have on the organisation's overall strategy. Being design-led in this way requires a company to have a vision for top-line growth based on customer insights, however Bucolo *et al.* (2012) identify organisational leadership gaps as a key hurdle in reaching this strategic vision. Specifically, these leadership gaps have been identified in areas such as: engaging with customers, observation, problem framing and adapting mentalities. This raises questions about the qualities that are possessed by strategic level leaders that enable them to successfully champion design amongst other disciplines within an organisation.

In part, this difficulty stems from the extent to which design practice is built upon implicit and deeply held beliefs that are central to the nature of design knowledge; which is often intangible and tacit in nature, yet provides designers with the capability to propose novel solutions to complex problems. In particular, tacit knowledge is at the core of many design activities (Pugh, 1990; Casakin, 2007; Cross, 2006); however, the intangible nature of this knowledge makes it difficult for designers to articulate it in a way that can be recognised by other disciplines.

Design knowledge is part of a broader suite of competencies that are capable of explaining the uniqueness of design within multidisciplinary situations (Gribbin *et al.*, 2016a). One way in which knowledge can manifest in individuals is through their attitude, which culminates to form a working culture within an organisation or team. Existing design attitude literature highlights the differences that exist between designers and management professionals, however this literature does not presently consider the way in which these attitudes are impacted under the conditions brought about through multidisciplinary collaboration.

Design attitude

The notion of a design attitude was first brought about by Boland and Collopy (2004); who made a series of observations based on the learning process undertaken by a group of management practitioners during an architectural project. These observations led to the inception of two distinct types of attitude that appeared to be present over the course of the project; they were termed a design attitude and a decision attitude. The decision attitude is more prominent within management disciplines, where there is an underlying assumption that it is easy to generate solutions to a problem, however it is difficult to make the correct choice amongst these solutions. Prominent features of the decision attitude within the decision making process are fear of risk, high costs or inefficiency, all of which underpin the decisions of managers when faced with implementing solutions to problems.

Contrastingly, a design attitude is described as a unique mind-set and approach to problem solving that allows designers to shape inspiring and energising designs for products, services and processes that are both profitable and humanly satisfying. The design attitude takes an approach to problem solving that fundamentally believes that it is difficult to develop a good solution to a problem; however through the implementation of design processes, when a great solution is finally derived the decision about which solution to implement becomes arbitrary. In this sense, designers have awareness that the cost of not conceiving a better solution to a particular problem might be even more costly to an organisation than not making the correct choice in the first instance.

Michlewski (2008) builds on the proposition of design attitude by empirically investigating the determinants of design attitude within design-led organisations. It was determined that five theoretical categories could characterise design attitude within the participants of the study.

These categories are: consolidating multidimensional meanings, creating – bringing to life, embracing discontinuity and open-endedness, embracing personal and commercial empathy and engaging polysensorial aesthetics. In this respect, 'design is seen as a professional culture and a set of deeply held beliefs which offer a compelling picture of the professional culture of designers and their attitudes and values shaping their work' (Augsten *et al.*, 2016, p. 1533). Subsequently, these determinants of attitude underpin the values invoked by managers and scholars within the discipline and as such contribute to the working culture of organisations.

Much of the research thus far has taken a macro view of design attitude, investigating the impact that it has on organisational culture in companies where design-driven innovation is at the core of organisational thinking. A gap remains in the literature for research which analyses the impact that design attitude can have within a micro context, within the dynamics of teams and individuals, particularly in the interdisciplinary context in which various attitudes will have an impact on working practices. It is this gap that this paper aims to address.

Research methodology

This paper follows a research approach consistent with grounded theory, which has been combined with case study analysis in order to investigate design attitude within a particular context. Grounded theory itself is a systematic generation of theory from data that has been obtained from social research (Glaser *in* Hussein *et al.*, 2014). It is an inductive method of generating theory through the simultaneous collection and analysis of data, with the goal of generating relevant and significant knowledge through social research. Within this paper, the goal of grounded theory was to generate fresh insights into the findings of an existing case study.

Yin (2014) identifies that case study research is a method of empirical enquiry that investigates a contemporary phenomenon in depth and within its real-world context; particularly when the boundaries between phenomenon and context may not be clearly evident. Similar to grounded theory, cases provide an opportunity to explore propositions and generate theory from the resulting data. Grounded theory is often limited in terms of its generalisability with theories often only relevant to the context in which they are derived (Stebbins, 2001). Combining it with case study research appears to mitigate the effects of this issue, as the use of cases begins to provide examples derived from multiple experiments that investigate phenomena through different perspectives (Lipset *et al.*, 1956; Hammersley *et al.*, 2000; Johansson, 2003).

Case selection

The case study itself is the result of a collaboration between Organisation A and a UK based University. Organisation A is a multinational consumer goods company that focuses on the production of health, hygiene and home products. The organisation has a series of brands that are available in nearly 200 countries, with several brands capable of being described as brand leaders in their respective markets. Innovation is at the core of the organisation, with the company describing a relentless strategy of creating innovative solutions to people's everyday challenges in health, hygiene and home, through high impact, consumer-led research. The organisation is driven by both technology and a consumer-focus in creating new products that are capable of improving the lives of their consumers.

Organisation A initially approached the University in order to collaborate on a packaging focused project with students of an undergraduate course. Upon completion of this project, the organisation then decided that it wished to carry out further work with the University. A subsequent project was carried out by a postgraduate programme and forms the focus of this particular case study. The postgraduate course is based on the philosophy that design-led innovation has the potential to redefine the way that we live, do business and create our future. To achieve this, a collaborative and multidisciplinary environment is created in which students work together in small teams on a range of commercial and social innovation projects with external organisations.

The primary aim of the project determined by Company A was to investigate compliance issues surrounding non-prescription painkillers in the pharmaceutical marketplace. The client had identified issues surrounding consumer engagement with product packaging and instructions, with a particular focus on issues surrounding people discarding the packaging of over the counter medications before reading instructions. Furthermore, the clients had predicted that a market shift towards technology-focused interactions with consumers was forthcoming, therefore it was also requested that the students aim to incorporate a future-technology driven focus within their research and ideation processes.

The student team that were working on the project consisted of six students from a range of backgrounds and experiences, a summary of which can be found in Table 1. Each student has been given a code that is used to reflect their discipline throughout the discussion section of the paper, with DG indicating graduates from a design background and BG indicating graduates from a business background (Table 1).

The student project team was supplemented by the advice of various lecturers from the University. Regular meetings were held with lecturers from design, business and technology disciplines, with further access to professionals throughout the University available when needed.

Subordinate methods

Within the spirit of case study research, Eisenhardt (1989) highlights that multiple methods of data collection are often utilised, which may be qualitative or quantitative in nature. Within this study the primary data collected was qualitative and collected through observation and reflective interviews. The project itself lasted for a duration of six weeks in which the researcher observed the students throughout the key stages of the project.

Upon completion of the project, two additional research methods were implemented. Firstly, a workshop was carried out with the students, with the goal of encouraging reflection. The workshop commenced with the stu-

Table 1. Students and their backgrounds and experiences.

Student/code	Background and experience
1 (DG)	Four year industrial design degree programme working on a range of projects for multinational clients. Additionally completed a four month placement at a design consultancy.
2 (BG)	French with business graduate. Self-described entrepreneur having established an online start-up business.
3 (BG)	Educated in biomedical science and food science before becoming a management trainee and product developer in a FMCG company, with 2.5 years training in different areas of the organisation.
4 (BG)	A business management graduate with experience in the cosmetic industry following graduation.
5 (DG)	An undergraduate degree in design and fashion, with a further three years working as a marketing professional for the outdoor brand Berghaus.
6 (BG)	A business leadership and corporate management graduate, with experience in a marketing focused freelance consulting role.

dents documenting a timeline of the project to provide a template for the workshop questions. Wording of the workshop questions was critically important in gaining as full a response as possible without offering solutions or leading the students in any way. In determining the skills and capabilities that were used throughout the project, students were asked to use the timeline to write down the corresponding skills that they felt they used at each stage of the project. Students were then asked to rank the skills that they improved most throughout the project, to determine which skills were present before the project and which were specifically developed throughout the project. In order to determine the knowledge utilised throughout the project, the students were asked to choose three key decisions that they made throughout the project and then explain the knowledge that underpinned these choices. This allowed them to ground the notion of knowledge within a context that was easier for them to understand, instead of asking them to explain the knowledge that they drew from throughout the project. Finally, participants were asked about the aspects of the projects that they found stimulating and the aspects that they found irritating.

Following the workshop, each of the students was interviewed using the repertory grid method. A repertory grid is a method for eliciting personal constructs in relation to a given topic. The method was derived by Kelly (1955); who expressed that people are continually engaged in the process of devising new theories, testing hypotheses based on these theories and acting on their findings (Giles, 2002). Kelly (1955) described this process as personal construct theory, arguing that individuals construct rational worlds based on their experiences, which shape a pattern that can be defined as 'personal constructs'. Candy (1990) describes a system of personal constructs as a repository of what a person has learned, a statement of their intent and the values by which they live. As a person builds up their construction of reality, more and more constructs are derived until eventually a complex and unique picture of one's reality is formed; thus demonstrating the way in which a person organises their social world, which is then open to interpretation. Within the context of this research, repertory grid based interviews afforded the students the opportunity to reflect on their project in a way that aided the understanding of the beliefs and assumptions that underpinned their decision making over the course of the project (Gribbin *et al.*, 2016b); thereby revealing more of the attitudes and aspects of the tacit knowledge that they had applied.

Discussion

Work seeking to understand the uniqueness of designers within multidisciplinary scenarios has generated several insights that are applied to designers in general. Further categorisation has occurred specifically within the design attitude literature, with Michlewski (2008) discussing several categories of design attitude that were pertinent throughout interviews with design professionals. Despite this research, there has been little discussion focusing on the interactions between design and other disciplines.

This section of the paper seeks to broaden the thinking in this area, by offering a statement that is generated from relevant theory, before discussing the occurrence of each statement as observed within the case study. The studies referenced within the discussion of each statement are a mix of evidence based studies and reflective propositions based on design practice. The evidence-based studies add credibility to the statements at this stage, however a further aim of this research is to add further evidence in documenting these claims.

Abductive reasoning is at the core of design thinking

Within design thinking, it is recognised that particular emphasis is often placed on the process of finding the right problem to focus on, through understanding the needs of markets and individuals as well as identifying future trends that can have an impact on the problem. Goel and Pirolli (1989) highlight that because of the ill-structured and complex nature of design problems, they require the problem solver to engage in an extensive problem structuring process. Michlewski (2008) refers to this as the consolidation of multidimensional meanings, in which designers have the ability to look at

a situation from a wide variety of perspectives, bringing a humanistic standpoint to problem solving. Tomiyama *et al.* (2003) suggest that creative design primarily stems from an innovative combination of existing knowledge, where abductive reasoning is central to integrating knowledge in particular circumstances.

Dorst (2011) suggests that designers tend to have deliberate strategies in order to tackle the creative challenge presented by particular problems, in which designers adopt a frame that can be applied to working principles in order to create specific values. Kolko (2010) highlights that this process of framing through the consolidation of meanings is typically one of the reasons that other disciplines can often fail to understand the processes of designers. When encountered in professional practice, Kolko (2010) suggests that the synthesis process is frequently performed privately with only the outcome being observed by onlookers, with this specifically occurring after the synthesis process has occurred and the form-making portion of the design process has begun. Synthesis is described as an insular activity that is less obviously understood or alternatively completely hidden from view.

Within this particular project, the students that were not from design backgrounds did not face this level of uncertainty within the problem framing and synthesis aspects of the project. In particular, the proportion of time that students spent on research throughout the project demonstrates that they valued highly the process of problem framing. This was echoed in the reflective workshop, where student 5 (DG) identified the research work done throughout the project as particularly important in defining the question. Student 3 (BG) echoed this, suggesting that the converging stages of the project were the most important, in which the team engaged in the process of problem framing based on their extensive research. All of the students followed an empathic, user-focused discovery process in which they set out to understand the problems that faced a variety of target consumers.

As part of the repertory grid interview, student 3 (BG) stated that they found certain aspects of the project difficult due to a feeling that they were not particularly contributing at certain stages of it. When questioned further on this, they were able to articulate that they found difficulty in stages of the project that were particularly divergent. Despite this, they felt that their biggest input into the project was during the problem framing stage, where their research skills and critical thinking in order to successfully synthesise findings were particularly important. This highlights that even a student who found difficulty in following certain aspects of the design process was able to have a large input into the problem framing stage, adopting a similar thought process to those that were more familiar with design practices.

Embracing discontinuity and open-endedness

One of the key features of design problems is that they are ambiguous and often stem from ill-defined requirements (Jonassen, 2000). Throughout the design-led problem solving process, there are multiple solution paths that can lead to a variety of end products (Lammi and Becker, 2013). Designers relish the lack of predetermined outcomes and they tend to approach new projects with a desire to experiment with materials, technologies and methods and to do something different and better than ever before. To do this, designers must work creatively within the established boundaries of a project and each project must be approached with a desire to experiment and do something unique and better than ever before (Carlopio, 2010).

Dealing with ambiguity within the project was an area in which the majority of students from a business background struggled. This was particularly evident in the early stages of the project where the students were only given a small amount of information with regards to the official brief. Students 3 (BG), 4 (BG), 5 (DG) and 6 (BG) particularly struggled with this aspect of the project, to the point that at one stage they were willing to temporarily halt working on the project until they were presented with a more in depth brief by the client. When questioned, this hesitancy stemmed from the fact that the students were used to situations within industry where they were given defined briefs and operated in a specific manner to solve the problems. Student 6 (BG) found this process particularly frustrating, expressing that it was difficult to work from a position in which the client expectations were not explicit. Contrastingly, student 1 expressed that ambiguous briefs had been common in their experience of design projects and that it was something that they were used to dealing with. Similarly, student 2 (BG) also expressed that they were comfortable working in ambiguous situations, primarily because they were used to working in this way on previous projects; however it is also important to note that student 2 (BG) has less experience working within industry situations and as a result is perhaps more open to new ways of working which would then become a norm.

From this, it appears that dealing with ambiguity within projects is something that sets designers apart from other disciplines and that it also requires a way of thinking that can be difficult to adopt for people that are not used to working in this way. It appears particularly difficult for people who are used to working on specific projects with plentiful information available at the outset to adopt a mindset that allows them to work in situations that they find ambiguous, whereas if people have experience in these types of situations they become more comfortable with the approach. Given the experiences of the business-based students, these situations do not appear to be common within the management roles that were held prior to the beginning of the programme. Furthermore, it appears that by spending time within a business-focused role, student 5 (DG) became accustomed to well defined briefs and struggled with the transition back towards ambiguous problem situations.

Creating, bringing to life

Yoo *et al.* (2006) express that form giving is essential to projecting a design identity into the world through ongoing design activity, projecting custom solutions to products or services that are capable of releasing new experiences into the marketplace. Smets *et al.* (1994) expand on this by demonstrating that designers have powerful abilities to convey complex, non-obvious information

using shape and colour. Junginger (2007) suggests that to achieve good design, designers must now be involved with a systematic inquiry beyond aesthetics and functions, however engaging in sketching, prototyping, testing, evaluating and refining ideas in two or three dimensional form all involve the process of translating ideas into actions which remain at the core of design activity.

Content analysis carried out on the workshop data indicated several activities carried out over the course of the project that can be associated with the process of bringing ideas to life. The students articulated skills in prototyping, storyboarding, video editing, 3D rendering, animation and persona creation that were consistent with this category. In terms of the distribution of these tasks, the engagement of business students varied. Students 2 (BG) and 6 (BG) played a large role in this process, particularly towards the end of the project when the team was tasked with creating more elaborate prototypes of their final concepts and creating videos that were capable of communicating the benefits of their ideas to the clients. In this respect, the two students adopted the culture of design making and largely participated in what would typically be considered as a design task. The primary difference between these two students and student 1 (DG) in this instance, was that student 1 (DG) possessed the necessary design skills to carry out more complex activities involved in the prototyping of ideas. This was particularly evident given student 1's proficiency in creating 3D renders of concepts and using more advanced physical prototyping methods, which had been explicitly developed through formal design training.

To a smaller extent student 5 (DG), engaged with the process through acts of sketching, however in comparison to students 2 (BG) and 6 (BG) this contribution was minimal. To an even greater extent, students 3 (BG) and 4 (BG) particularly struggled with this element of the project. Student 3 (BG) expressed that they felt like they were not able to contribute to this process at all due to a lack of an ability to draw particularly well. This suggests that in order for business oriented people to engage with a design attitude when it is necessary to bring ideas to life, a confidence in a person's own ability to draw and visualise concepts through sketching is the minimum requirement for people to feel engaged with the process.

Attitudes toward concept selection

As previously highlighted, Boland and Collopy (2004) discuss the differences between design and management disciplines in terms of decision making during the problem solving process. Those with a decision attitude were seen to struggle with concept selection decisions due to a fear of risk, whilst those with a design attitude were more comfortable in concept selection based on an inherent belief in the concept inception process. The contrast between design and decision attitude was particularly evident within the project when students were in the process of synthesising their ideas in order to determine which had the most value to their work. The students settled on a decision matrix that allowed them to score their ideas in terms of value to the client and also the consumers. Once the students had scored what they perceived to be their strongest ideas, there was a disagreement as to whether the remaining ideas should also be scored. Student 1 (DG) felt that this process would be a waste of time at this stage of the project and that the ideas currently in line to go forward were the strongest available to the team. Conversely, students 3 (BG) and 4 (BG) felt that it was necessary to score the remaining ideas to be sure that the strongest ideas actually went forward for selection.

This instance demonstrated opposing differences between people of different backgrounds almost exactly as described within the literature. Students 3 (BG) and 4 (BG) felt that it was particularly difficult to choose between solutions at this stage and exhibited a fear of making the incorrect choice at this stage of the process. They felt that it was risky to develop the concepts that had been ranked without first ranking every single idea that the team had because they feared making the wrong selection at this stage. Conversely, student 1 (DG) felt that at this stage the best concepts were obvious because they were the really great solutions that met the needs of consumers outlined in the extensive problem framing process. Subsequently, it appears that attitudes towards risk are something that differs strongly even within multidisciplinary collaboration. Those from business backgrounds were more risk adverse at this stage of the project, whereas the designer was less concerned with risk at this stage due to an inherent belief in the working processes of the team.

Conclusion

An increase in design management literature has seen various strands of research that seek to explicate the knowledge offered by designers within the context of multidisciplinary situations. Despite this, the intangible nature of design can make this a difficult endeavour. In attempting to explicate some of the factors that underpin the success of design, authors such as Boland and Collopy (2004) and Michlewski (2008) have attempted to understand the attitudes of designers and the relevance of this in creating an organisational culture that is conductive of strong design principles in the problem solving process. Whilst this literature is conclusive in suggesting the attitudes of designers, it does not presently consider the relationship between attitudes within a multidisciplinary context. This paper has aimed to address this gap, by examining the attitudes of designers and business people within the context of a postgraduate collaborative project.

It was found that business students were capable of engaging with the abductive reasoning that underpins the traditional design thinking process, which was somewhat surprising given existing literature's suggestion that the abductive logic can often be hard for people to follow due to its intangible nature. Furthermore, it was found that business and design share similarities in the process of bringing things to life, however these similarities were dependent on the extent to which business students felt confident in processes such as sketching. Where students felt that they lacked this proficiency, they struggled in their ability to adopt this way of thinking and impact this area of the project.

One of the primary differences between the two disciplines was the attitude towards risk during the concept

selection stage of the project. Business students displayed the attributes of a decision attitude in that they were risk adverse in selecting concepts, however the designers did not reciprocate this view due to an underlying belief in the application of the design process. Furthermore, dealing with ambiguity also proved to be a dividing factor between the two disciplines, with the business students finding this aspect of the project particularly difficult to navigate, whereas the design student thrived under those conditions voicing an enjoyment of the project brief.

Limitations

The study faces limitations in the fact that it takes an in-depth view into a single study as opposed to a broader view of multiple cases. As such, it is difficult to generalise the results beyond their application within future student projects at this juncture. As such, a replication of the study with a larger sample and access to more disciplines would be necessary to further this research in the future, which would add further validity to the findings.

Implications

The research has implications for both professional practice and on going research into multidisciplinary practice. By exposing aspects of the design attitude that are relatable to people from business backgrounds, the research perhaps offers a fresh perspective for designers dealing with the task of communicating their practice to people from different disciplines. It has the potential to make aspects such as the problem framing process more explicit in these discussions, in the knowledge that it will be made relatable to people from business backgrounds. Furthermore, the work highlights aspects of attitudes such as dealing with ambiguity and concept selection as aspects of work to which designers bring a unique perspective, thus adding extra value to this stage of the problem solving process.

For future research, the research methods of the study appear to be particularly relevant to capturing attitudes within a professional context. A mixed method approach of observation, reflective workshops and repertory grid interviews allowed a collection of data that was reliable given the similarities in the data collected through each method. Observation allowed an independent researcher to capture data within the context of the collaborative project, whilst the workshop and repertory grid interviews allowed the students to reflect on their practice at a deeper level consistent with double-loop reflective practice (Argyris, 1976); in order to understand their beliefs and attitudes that are intrinsic to their working practices and articulate these in a way which would not have been possible through alternative methods.

References

AFTAB, M. 2013. *Design as a functional leader: A case study to investigate the role of design as a potential leading discipline in multinational organisations.* Newcastle upon Tyne, UK. PhD thesis. Northumbria University, 444 p.

ARGYRIS, C. 1976. *Increasing leadership effectiveness.* New York, Wiley, 286 p.

AUGSTEN, A.; GEBHARDT, V.; MAISCH, B. 2016. Change by design? Organizational learning barriers in the German automotive industry. *In:* 20th DMI: Academic Design Management Conference, Boston, 2016. *Proceedings…* Boston, p. 1529-1546.

BAREGHEH, A.; ROWLEY, J.; SAMBROOK, S. 2009. Towards a multidisciplinary definition of innovation. *Management decision,* **47**(8):1323-1339.

BOLAND, R.; COLLOPY, F. (eds.) 2004. *Managing as Designing.* Stanford, Stanford University Press, 312 p.

BROWN, T. 2008. Design thinking. *Harvard Business Review,* **86**(6): 84-92.

BROWN, T. 2009. *Change by design.* New York, Harper Collins Publishers, 264 p.

BUCOLO, S.; WRIGLEY, C.; MATTHEWS, J. 2012. Gaps in organizational leadership: Linking strategic and operational activities through design-led propositions. *Design Management Journal,* **7**(1):18-28.

CANDY, P. 1990. Repertory grids: Playing verbal chess. *In:* J. MEZIROW (ed.), *Fostering critical reflection in adulthood: a guide to transformative and emancipatory learning.* San Francisco, Jossey-Bass Publishers, p. 271-295.

CARLOPIO, J. 2010. *Strategy by design.* New York, Palgrave MacMillan, 199 p.

CASAKIN, H.P. 2007. Metaphors in design problem solving: Implications for creativity. *International Journal of Design,* **1**:21-33.

CROSS, N. 2006. *Designerly ways of knowing.* London, Springer-Verlag London, 114 p.

DORST, K. 2011. The core of 'design thinking' and its application. *Design Studies,* **32**:521-532.

EISENHARDT, K. 1989. Building theories from case study research. *The Academy of Management Review,* **14**(4):532-550.

GILES, D. 2002. *Advanced research methods in psychology.* New York, Routledge, 351 p.

GRIBBIN, J.; YOUNG, R.; AFTAB, M. 2016a. Towards a holistic framework of design competence. *In:* 20th DMI: Academic Design Management Conference, Boston, 2016. *Proceedings…* Boston, p. 1886-1911.

GRIBBIN, J.; YOUNG, R.; AFTAB, M.; PARK, S. 2016b. Double-loop reflective practice as an approach to understanding knowledge and experience. *In:* Design Research Society 50th Anniversary Conference, Brighton, 2016. *Proceedings…* Brighton, **8**:3181-3198.

GOEL, V.; PIROLLI, P. 1989. Motivating the notion of generic design within information-processing theory: The design problem space. *AI magazine,* **10**:18-36 p.

HAMMERSLEY, M.; FOSTER, P.; GOMM, R. 2000. Case study and generalisation. *In:* R. GOMM; M. HAMMERSLEY; P. FOSTER (eds.), *Case study method: Key issues, Key texts.* London, Sage, p. 98-116.

HUSSEIN, M.E.; HIRST, S.; SALYERS, V.; OSUJI, J. 2014. Using grounded theory as a method of inquiry: Advantages and disadvantages. *The Qualitative Report,* **19**:1-15.

JOHANSSON, R. 2003. Case study methodology. *In:* The International Conference on Methodologies in Housing Research, Stockholm, 2003. *Proceedings…* Stockholm, p. 1-14.

JONASSEN, D.H. 2000. Toward a design theory of problem solving. *Educational Technology Research and Development,* **48**:63-85.

JUNGINGER, S. 2007. Learning to design: giving purpose to heart, hand and mind. *Journal of Business Strategy,* **28**:59-65.

KELLY, G. 1955. The nature of personal constructs. *The psychology of personal constructs,* **1**:105-183.

KOLKO, J. 2010. Abductive thinking and sensemaking: The drivers of design synthesis. *Design Issues,* **26**(1):15-28.

KOLKO, J. 2015. Design thinking comes of age. *Harvard Business Review,* September, p. 2-7.

LAMMI, M.; BECKER, K. 2013. Engineering design thinking. *Journal of Technology Education*, **24**(2):55-77

LIPSET, S.M.; TROW, M.; COLEMAN, J. 1956. *Union democracy: The inside politics of the International Typographical Union.* Glencoe, Free Press. Lipset Union Democracy: The Inside Politics of the International Typographical Union.

LOCKWOOD, T. 2009. *Design thinking: Integrating innovation, customer experience, and brand value.* New York, Allworth Press, 285 p.

MARTIN, R. 2009. *The design of business: Why design thinking is the next competitive advantage.* Boston, Harvard Business School Publishing, 190 p.

MICHLEWSKI, K. 2008. Uncovering design attitude: Inside the culture of designers. *Organization Studies,* **29**:373-392.

NORMAN, D.A.; VERGANTI, R. 2014. Incremental and radical innovation: Design research vs. technology and meaning change. *Design Issues,* **30**(1):78-96.

PUGH, S. 1990. *Total design: Integrated methods for successful product engineering.* Harlow, Pearson Education, 296 p.

REUVENI, Y.; VASHDI, D.R. 2015. Innovation in multidisciplinary teams: The moderating role of transformational leadership in the relationship between professional heterogeneity and shared mental models. *European Journal of Work and Organizational Psychology,* **24**:678-692.

SEIDEL, V.P.; FIXSON, S.K. 2013. Adopting design thinking in novice multidisciplinary teams: The application and limits of design methods and reflexive practices. *Journal of Product Innovation Management,* **30**:19-33.

SIMON, H.A. 1955. A behavioral model of rational choice. *The Quarterly Journal of Economics,* **69**(1):99-118.

SMETS, G.; OVERBEEKE, K.; GAVER, W. 1994. Form-giving: expressing the nonobvious. *In:* Conference on Human Factors in Computing Systems, Boston, 1994. *Proceedings…* Boston, p. 79-84.

STACEY, R.D.; GRIFFIN, D.; SHAW, P. 2000. *Complexity and management: fad or radical challenge to systems thinking?* London, Routledge, 224 p.

STEBBINS, R.A. 2001. *Exploratory research in the social sciences.* Thousand Oaks, Sage, 80 p.

TOMIYAMA, T.; TAKEDA, H.; YOSHIOKA, M.; SHIMOMURA, Y. 2003. Abduction for creative design. *In:* International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, 2003. *Proceedings…* American Society of Mechanical Engineers, p. 543-552.

VERGANTI, R. 2009. *Design-driven innovation: Changing the rules of competition by radically innovating what things mean.* Boston, Harvard Business School Publishing Corporation, 272 p.

YIN, R. 2014. *Case study research: Design and methods.* Thousand Oaks, Sage Publications Inc., 282 p.

YOO, Y.; BOLAND JR, R.J.; LYYTINEN, K. 2006. From organization design to organization designing. *Organization Science,* **17**:215-229.

Submitted on September 30, 2016
Accepted on May 1, 2017

References

Acklin, C. (2013) *Design management absorption in SMEs with little or no prior design experience*. PhD thesis. Lancaster University.

Aftab, M. (2013) *Design as a functional leader: A case study to investigate the role of design as a potential leading discipline in multinational organisations*. PhD thesis. Northumbria University.

Alexander, C. (1964) *Notes on the synthesis of form.* Cambridge: Harvard University Press.

Alvesson, M. (2002) *Understanding organizational culture*. London: Sage Publications.

Ananiadou, K. & Claro, M. (2009) '21st Century skills and competences for new millennium learners in OECD countries', *OECD.* [Online]. Available at: http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=edu/wkp(2009)20&doclanguage=en (Accessed: 9 April 2018).

Anderson, N. (1990) 'Repertory grid technique in employee selection', *Personnel Review,* 19 (3), pp. 9-15.

Andrew, D. P., Pedersen, P. M. & Mcevoy, C. D. (2011). *Research methods and design in sport management.* Champaign: Human Kinetics.

Andrews, K. R. (1971) 'The concept of corporate strategy', In Foss, N (ed.) *Resources, firms and strategies.* Oxford: Oxford University Press, p. 52.

Ansoff, H. I. (1957) 'Strategies for diversification', *Harvard business review,* 35 (5), pp. 113-124.

Archer, B. (1964) Systematic Method for Designers, Design Magazine, 1963-1964.

Archer, B. (1979) 'Design as a discipline', *Design Studies,* 1 (1), pp. 17-20.

Archer, B. (1995) 'The nature of research', *Co-Design Journal,* 2 (1), pp. 6-13.

Argyris, C. (1976) *Increasing leadership effectiveness*. New York: Wiley.

Argyris, C & Schön, D (1974) *Theory in practice: Increasing professional effectiveness*. San Francisco: Jossey-Bass Publishers.

Backes, B. & Wolff, F. (2016) ‘Design Management and Maturity: an analysis of the publications of DMI Review’, *20th DMI: Academic Design Management Conference, Inflection Point: Design Research Meets Design Practice*. Boston:DMI. 28-29 July.

Bailey, K. (1987) *Methods of Social Research.* New York: The Free Press.

Baker, M. J. (2000) ‘Writing a Literature Review’, *The Marketing Review,* 1 (2), pp. 219-247.

Barab, S. A., Thomas, M. K., Dodge, T., Squire, K. & Newell, M. (2004). ‘Critical Design Ethnography: Designing for Change’, *Anthropology & Education Quarterly,* 35 (2), pp. 254-268.

Barney, J. (1991) ‘Firm resources and sustained competitive advantage’, *Journal of management,* 17 (1), pp. 99-120.

Basit, T. (2003) ‘Manual or electronic? The role of coding in qualitative data analysis’, *Educational research,* 45 (2), pp. 143-154.

Battistella, C., Biotto, G. & De Toni, A. F. (2012) ‘From design driven innovation to meaning strategy’, *Management Decision,* 50 (4), pp. 718-743.

Baxter, P. & Jack, S. (2008) ‘Qualitative case study methodology: Study design and implementation for novice researchers’, *The qualitative report,* 13 (4), pp. 544-559.

Bayazit, N. (2004) ‘Investigating design: A review of forty years of design research’, *Design Issues,* 20 (1), pp. 16-29.

Bazeley, P. (2007) *Qualitative data analysis with NVivo.* London: Sage Publications.

Beardsley, S. (1994) The product interface: Crossroads of communication. *Design Management Review,* 5 (1), pp. 52-67.

Beltagui, A., Candi, M. & Riedel, J. C. (2012) ‘Design in the experience economy: Using emotional design for service innovation’, *Interdisciplinary Approaches to Product Design, Innovation, & Branding in International Marketing*, 23 (1), pp. 111-135.

Berg, B. (2009) *Qualitative research methods for the social sciences.* Boston: Allyn and Bacon.

Best, K., Kootstra, G. & Murphy, D. (2010) ‘Design management and business in Europe: a closer look’, *Design Management Review,* 21 (2), pp. 26-35.

Birkinshaw, J., Bouquet, C. & Barsoux, J.L. (2011) ‘The 5 myths of innovation’, *MIT Sloan Management Review,* 52 (2), pp. 43-50.

Birt, L., Scott, S., Cavers, D., Campbell, C. & Walter, F. (2016) ‘Member Checking:A Tool to Enhance Trustworthiness or Merely a Nod to Validation?’, *Qualitative Health Research,* 26 (13), pp. 1802-1811.

Björklund, L. (2008) The Repertory Grid Technique: Making Tacit Knowledge Explicit: Assessing Creative Work and Problem Solving Skillls. In: *Researching Technology Education: Methods and Techniques,* Howard Middleton (ed.) Rotterdam: Sense Publishers, pp. 46-69.

Blair, E. (2015) ‘A reflexive exploration of two qualitative data coding techniques’, *Journal of Methods and Measurement in the Social Sciences,* 6 (1), pp. 14-29.

Blaxter, L., Hughes, C. & Tight, M. (2010) *How To Research*, (4th ed.) Berkshire: Open University Press.

Bloch, P. H. (1995) ‘Seeking the ideal form: Product design and consumer response’, *The Journal of Marketing*, 59 (3), pp. 16-29.

Bloch, P. H. (2011) ‘Product design and marketing: Reflections after fifteen years’, *Journal of Product Innovation Management,* 28 (3), pp. 378-380.

Bloor, M. (1978) ‘On the Analysis of Observational Data: A Discussion of the Worth and Uses of Inductive Techniques and Respondent Validation’, *Sociology,* 12 (3), pp. 545-552.

Boland, R. & Collopy, F. (2004) *Managing as Designing,* California: Stanford University Press.

Boote, D. N. & Beile, P. (2005) ‘Scholars before researchers: On the centrality of the dissertation literature review in research preparation’, *Educational researcher,* 34 (6), pp. 3-15.

Borja de Mozota, B. (1998) ‘Structuring strategic design management: Michael Porter's value chain’, *Design Management Review,* 9 (2), pp. 26-31.

Borja de Mozota, B. (2003) *Design management: Using design to build brand value and corporate innovation.* New York: Allworth Press.

Borja de Mozota, B. (2006) 'The four powers of design: A value model in design management', *Design Management Review,* 17 (2), pp. 44-53.

Brazier, S. (2004) 'Walking Backward into Design: Support for the SME', *Design Management Review,* 15 (4), pp. 61-70.

Brown, S. & Eisenhardt, K. (1997) 'The art of continuous change: Linking complexity theory and time paced evolution in relentlessly shifting organisations', *Administrative Science Quarterly,* 42 (1), pp. 1-34.

Brown, T. (2007) Intersections, Newcastle: Northumbria University [Online] Available at: http://www.designcouncil.org.uk/en/Design-Council/1/What-we-do/Our- activities/Intersections-07/ (Accessed: 15 October 2015).

Brown, T. (2008) 'Design thinking', *Harvard business review,* 86, p. 84.

Brown, T. (2009) *Change by design.* New York: Harper Collins Publishers.

Bryman, A. (2012) *Social research methods.* New York: Oxford University Press.

Buchanan, R. (1992) 'Wicked problems in design thinking', *Design Issues,* 8 (2), pp. 5-21.

Buchanan, R. (2004) 'Management and design: Interaction pathways in organisational life', In: Boland, R. & Collopy, F. (ed.) *Managing as Designing.* Stanford: Stanford University Press, pp. 54-63.

Bucolo, S. & Matthews, J. H. (2011a) 'A conceptual model to link deep customer insights to both growth opportunities and organisational strategy in SMEs as part of a design led transformation journey', *Design management toward a new Era of innovation*. Hong Kong Convention and Exhibition Centre, Honk Kong.

Bucolo, S. & Matthews, J. H. (2011b) 'Design led innovation: Exploring the synthesis of needs, technologies and business models', *Proceedings of Participatory Interaction Conference.* Sønderborg, Denmark, 13-15 January, pp. 1-4.

Bucolo, S., Wrigley, C. & Matthews, J. (2012) ‘Gaps in organizational leadership: Linking strategic and operational activities through design-led propositions’, *Design Management Journal,* 7 (1), pp. 18-28.

Bucolo, S. (2016) *Are we there yet? Insights on how to lead by design*. Amsterdam: BIS Publishers.

Burke, V. & Collins, D. (2005) ‘Optimising the effects of leadership development programmes: A framework for analysing the learning and transfer of leadership skills’, *Management Decision*, 43 (7/8), pp. 975-987.

Bushe, G. (1995) ‘Advances in appreciative inquiry as an organisation development intervention’, *Organisation Development Journal*, 13 (3), pp. 14-22.

Camerer, C. (1985) ‘Redirecting research in business policy and strategy’, *Strategic Management Journal,* 6 (1), pp. 1-15.

Campbell, J. L., Quincy, C., Osserman, J. & Pedersen, O. K. (2013) ‘Coding in-depth semistructured interviews: Problems of unitization and intercoder reliability and agreement’, *Sociological Methods & Research,* 42 (3), pp. 294-320.

Candy, P. (1990) ‘Repertory grids: Playing verbal chess’, In: Mezirow, J. (ed.) *Fostering critical reflection in adulthood: a guide to transformative and emancipatory learning*. Michigan: Jossey-Bass Publishers.

Cantarello, S., Nosella, A., Petroni, G. & Venturini, K. (2011) ‘External technology sourcing: evidence from design-driven innovation’, *Management Decision,* 49 (6), pp. 962-983.

Carlgren, L., Elmquist, M. & Rauth, I. (2016) ‘The Challenges of Using Design Thinking in Industry–Experiences from Five Large Firms’, *Creativity and Innovation Management,* 25 (3), pp. 344-362.

Carnegie Mellon University CMMI Product Team (2002). Capability Maturity Model® Integration (CMMI), Version 1.1--Continuous Representation. [Online]. Available at: http://repository.cmu.edu/cgi/viewcontent.cgi?article=1622&context=sei (Accessed: 9 April 2018).

Casakin, H. P. (2007). ‘Metaphors in design problem solving: Implications for creativity’, *International Journal of Design,* 1 (2), pp. 21-33.

Cautela, C. & Zurlo, F. (2012) ‘Ambidexterity and dynamic capabilities in design management: an anatomy’, *International Journal of Entrepreneurship and Innovation Management,* 15 (4), pp. 310-335.

Charmaz, K. (1990). ‘Discovering chronic illness: Using grounded theory’, *Social Science & Medicine*, 30 (11), pp. 1161-1172.

Charmaz, K. (2006) *Constructing grounded theory: A practical guide through qualitative analysis*. London: Sage Publications.

Charmaz, K. & Smith, J. (2003) *Grounded theory. Qualitative psychology: A practical guide to research methods*. London: Sage Publications, pp. 81-110.

Chatman, J. A. (1991) ‘Matching People and Organizations: Selection and Socialization in Public Accounting Firms’, *Administrative Science Quarterly,* 36 (1), pp. 459-484.

Chatzakis, E. (2015) *Maintaining agility: A study of obscure new product development practices in small and medium sized manufacturing enterprises to understand how they maintain relevance to their markets*. PhD thesis. Northumbria University.

Chi, M. T., Feltovich, P. J. & Glaser, R. (1981) ‘Categorization and representation of physics problems by experts and novices’, *Cognitive science,* 5 (2), pp. 121-152.

Chiesa, V., Coughlan, P. & Voss, C. ‘1996) ‘Development of a technical innovation audit’, *Journal of Product Innovation Management,* 13 (2), pp. 105-136.

Connelly, M., Gilbert, J., Zaccaro, S., Threlfall, V., Marks, M. & Mumford, M. (2000) ‘Exploring the relationship of leadership skills and knowledge to leader performance’, *The Leadership Performance*, 11 (1), pp. 65-86.

Cooper, A. (2004) *An investigation into communication studies to improve the designer's understanding of the virtues and constraints of the three dimensional graphical user interface*. PhD thesis. Northumbria University.

Cooper, R., Hernandez, R., Murphy, E. & Tether, B. (2016) *Design value: The role of design in innovation*. [Online]. Available at: http://imagination.lancs.ac.uk/news/Design_Value (Accessed: 7 April 2018).

Cooper, R. & Press, M. (1995) *The design agenda: A guide to successful design management*. West Sussex: John Wiley & Sons Ltd.

Cooper, R. G. (1990). ‘Stage-gate systems: a new tool for managing new products’, *Business horizons,* 33 (3), pp. 44-54.

Cooperrider, D. & Whitney, D. (2001) ‘A positive revolution in change: Appreciative inquiry’, *Public administration and public policy*, 87 (1), pp. 611-630.

Cox, G. (2005) *The Cox Review of Creativity in Business*. London: UK Government.

Coyne, R. (1988) *Logic models of design.* London: Pitman.

Coyne, R. (2005) ‘Wicked problems revisited’, *Design Studies,* 26 (1), pp. 5-17.

Cresswell, J. (1994) *Qualitative and quantative approaches.* London: Sage Publications.

Cresswell, J. (2002) *Research design: Qualitative, quantitative and mixed method approaches*. London: Sage Publications.

Cross, N. (1984) *Developments in Design Methodology*. Chichester: John Wiley.

Cross, N. (2001) ‘Designerly ways of knowing: Design discipline versus design science’, *Design issues,* 17 (3), pp. 49-55.

Cross, N. (2006). *Designerly ways of knowing*, London: Springer.

Cross, N. (2007) ‘Forty years of design research’, *Design studies,* 28 (1), pp. 1-4.

Cross, N. (2008) *Designerly ways of knowing*. Berlin: Birkhauser.

Crotty, M. (1998) *The foundations of social research: Meaning and perspective in the research process*. London: Sage Publications.

Crouch, C. & Pearce, J. (2012) *Doing research in design.* London: Berg Publishers.

Crudge, S. & Johnson, F. (2007) ‘Using the repertory grid and laddering technique to determine the user's evaluative model of search engines’, *Journal of Documentation,* 63 (2), pp. 259-280.

D’este, P., Iammarino, S., Savona, M. & Von Tunzelmann, N. (2012) ‘What hampers innovation? Revealed barriers versus deterring barriers’, *Research policy,* 41 (2), pp. 482-488.

Daft, R. L. (1983). *Organisation theory and design*. New York: Cengage Learning.

Danish Design Centre. (2015) *The design ladder: four steps of design use.* Available: http://danskdesigncenter.dk/en/design-ladder-four-steps-design-use (Accessed: 22 June 2017).

Dauber, D., Fink, G. & Yolles, M. (2012) 'A configuration model of organizational culture', *Sage Open,* 2 (1), pp. 1-16.

De Goey, H., Hilletofth, P. & Eriksson, D. (2016a) 'Enablers and barriers to design-driven innovation: a case study at a Swedish wood furniture wholesaler', *Proceedings of the 23rd International Annual EurOMA Conference*. Trondheim, 17-22 June.

De Goey, H., Hilletofth, P. & Eriksson, L. (2016b). 'Design Driven Innovation: A Literature Review', *20th DMI: Academic Design Management Conference, Inflection Point: Design Research Meets Design Practice*. Boston:DMI. 28-29 July.

Dean, P. (2016) 'Free for all', in Sparke, P. & Fisher, F. (ed.) The Routledge companion to design research. Oxon: Routledge, pp. 21-28.

Dell'era, C. & Verganti, R. (2009) 'Design−driven laboratories: organization and strategy of laboratories specialized in the development of radical design−driven innovations', *R&D Management,* 39 (1), pp. 1-20.

Design Management Institute. (2015) *The value of design.* Available: http://www.dmi.org/?DesignValue (Accessed: 19 June 2017).

Dewalt, K. & Dewalt, B. (2011) *Participant observation: A guide for fieldworkers*. Plymouth: AltaMaria Press.

Dewey, J. (1997) *How we think.* Boston: D.C Heath and Co Publishers.

Dey, I. (1993) *Qualitative data analysis: A user-friendly guide for social scientists*. London: Routledge.

Dickson, T. (2002). *Designforskning en international oversigtt.* Aarhus: Arkitektskolens Forlag.

Design Management Institute. (2015) *The value of design*. Available at: http://www.dmi.org/?DesignValue (Accessed: 19 June 2017).

Doherty, R., Wrigley, C., Matthews, J. H. & Bucolo, S. (2014) ‘Climbing the design ladder: step by step’, *Proceedings of 19th DMI: Academic Design Management Conference: Design Management in an Era of Disruption*. London: DMI. 2-4 September.

Dorst, K. (2011) ‘The core of ‘design thinking’ and its application’, *Design Studies,* 32 (1), pp. 521-532.

Douglas, J. D. (1976) *Investigative social research: Individual and team field research*. Beverly Hills: Sage Publications.

Drucker, P. (2002) ‘They're not employees, they're people’, *Harvard Business Review,* 80 (2), pp. 70-77.

Dubberly, H. (2005) *How do you design? A compendium of models*. San Fransisco: Dubberly Design Office.

Duffy, F. & Powell, K. (1997) *The new office*. London: Conrad Octopus.

Dumas, A. & Mintzberg, H. (1989) ‘Managing design Designing management’, *Design Management Journal (Former Series),* 1 (1), pp. 37-43.

Dunn, K. (2005) ‘Interviewing’,. In Hay, I. (ed.) *Qualitative reserach methods in human geography*. 2nd ed. London: Oxford University Press.

Eisenhardt, K. M. (1989) ‘Building theories from case study research’, *The Academy of Management Review,* 14 (4), pp. 532-550.

Elmquist, M. (2007) ‘Vehicles for innovation and learning: the case of a neglected concept car project’, *Knowledge and Process Management,* 14 (1), pp. 1-14.

Erlandson, D., Harris, E., Skipper, B. & Allen, S. (1993). *Doing naturalistic inquiry*. London: Sage Publications.

Essmann, H. & Du Preez, N. (2009) ‘An innovation capability maturity model–development and initial application’, *World Academy of Science, Engineering and Technology,* 3 (5), pp. 435-446.

European Commission. (2015) *Innobarometer 2015 - The innovation trends at EU enterprises*.

Findeli, A. (1998). ‘A quest for credibility: Doctoral education and research in design at the University of Montreal’, *Doctoral Education in Design.* Ohio, 8-11 October.

Fransella, F., Bell, R. & Bannister, D. (2004) *A manual for repertory grid technique*. Chichester: John Wiley & Sons.

Fraser, P., Moultrie, J. & Gregory, M. (2002) ‘The use of maturity models/grids as a tool in assessing product development capability’, *IEEE International Engineering Management Conference*, Vol. 241, pp. 244-249

Frayling, C. (1993) Research in art and design. *Royal College of Art Research Papers,* 1 (1), pp. 1-5.

Friedman, K. (2002) ‘Towards an integrative design discipline’, in Squires, S., & Byrne, B. (ed.) *Creating breakthrough ideas: the collaboration of anthropologists and designers in the product development industry*. London: Bergin and Gravey, pp. 199-214.

Friedman, K. (2003) ‘Theory construction in design research: criteria: approaches, and methods’, *Design studies,* 24 (6), pp. 507-522.

Gardien, P. & Gilsing, F. (2013) ‘Walking the walk: Putting design at the heart of business’, *Design Management Review,* 24 (2), pp. 54-66.

Gergen, D. (1994) *Realities and relationships: Soundings in social construction*. Cambridge, MA: Harvard University Press.

Gerring, J. (2013) ‘The Case Study: What it is and What it Does’, *In:* Goodin, R. (ed.) *The oxford handbook of political science.* New York: Oxford University Press.

Giles, D. (2002) *Advanced research methods in psychology.* New York: Routledge.

Gill, J. & Johnson, P. (2010) *Research methods for managers.* London,: Sage Publications.

Girling, R. 2015. *Design Maturity Survey.* [Online]. Available: https://www.artefactgroup.com/content/design-maturity-survey/ (Accessed: 26 June 2017).

Glanville, R. (1999) ‘Researching Design and Designing Research’, *Design Issues,* 15 (2), pp. 80-91.

Glaser, B. (1978). *Theoretical sensitivity: Advances in methodology of grounded theory*. San Francisco: University of California Press.

Glaser, B. & Strauss, A. (1967) *The discovery of grounded theory. Strategies for qualitative research*. Chicago: Aldine Publishing Company.

Goel, V., Gold, B., Kapur, S. & Houle, S. (1997) 'The seats of reason? An imaging study of deductive and inductive reasoning', *NeuroReport,* 8 (5), pp. 1305-1310.

Gottschalk, P. (2009) 'Maturity levels for interoperability in digital government', *Government Information Quarterly,* 26 (1), pp. 75-81.

Govindarajan, V. & Trimble, C. (2010) *The other side of innovation.* Boston: Harvard Business Review Press.

Grant, K. P. & Pennypacker, J. S. (2006) 'Project management maturity: An assessment of project management capabilities among and between selected industries', *IEEE Transactions on engineering management,* 53 (1), pp. 59-68.

Graue, M. & Walsh, D. (1998) *Studying children in context: Theories, methods, and ethics*. Thousand Oaks: Sage Publications

Gray, C. (2014) 'Evolution of design competence in UX practice', *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, Ontario, Canada. April 26 - May 1. pp. 1645-1654.

Gray, D. E. (2014) *Doing research in the real world*. London: Sage Publications.

Gribbin, J., Young, R., Aftab, M. & Park, S. (2016) 'Double-loop reflective practice as an approach to understanding tacit knowledge and experience', *Design Research Society 50th Anniversary Conference.* Brighton, UK.

Gribbin, J., Young, R. & Aftab, M. (2017) 'Understanding the dynamics of attitudes within a design and business focused collaboration', *Strategic Design Research Journal,* 10 (2), pp. 126-133.

Grönroos, C. (1997) 'Keynote paper From marketing mix to relationship marketing-towards a paradigm shift in marketing', *Management Decision*, 35 (4), pp. 322-339.

Guba, E. & Lincoln, Y. (1985). *Naturalistic inquiry.* Beverly Hills: Sage Publications.

Guba, E. & Y, L. 1989. *Fourth generation evaluation,* Newbury Park: Sage Publications.

Hakkio, S. & Laaksonen, P. (1998) 'Relationships in marketing channels: Examining communication abilities through cognitive structures', *Psychology & Marketing (1986-1998),* 15 (3), pp. 215-240.

Han, J. & Bromilow, D. (2010) 'Graphic designers win the leadership game', *Design Management Journal*, 5 (1), pp. 20-31.

Hands, D. (2009) *Vision and values in design management*. Switzerland: AVA Publishing.

Hansen, M. T. & Von Oetinger, B. (2001) 'Introducing T-shaped managers', *Harvard business review,* 79 (3), pp. 106-116.

Harris, J., Pryor, J. & Adams, S. (2006). The challenge of intercoder agreement in qualitative inquiry. [Online]. Available at: https://www.researchgate.net/profile/Judith_Harris4/publication/228490436_The_challenge_of_intercoder_agreement_in_qualitative_inquiry/links/0c960527a47d4845d1000000/The-challenge-of-intercoder-agreement-in-qualitative-inquiry.pdf (Accessed: 9 April 2018).

Hatch, M. & Cunliffe, A. (2006) *Organisation theory*. Oxford: Oxford University Press.

Hayes, R. (1985) 'Strategic planning - Forward in Reverse', *Harvard Business Review* [Online] Available at: https://hbr.org/1985/11/strategic-planning-forward-in-reverse (Acessed: 9 April 2018).

Herriott, R. E. & Firestone, W. A. (1983) 'Multisite qualitative policy research: Optimizing description and generalizability', *Educational researcher,* 12 (2), pp. 14-19.

Heskett, J. (2002) *Toothpicks and Logos: Design in Everyday Life*. London: Oxford University Press.

Heskett, J. (2005). 'A design policy for the UK: Three suggestions', *In:* Dilnot, C. (ed.) *A John Heskett Reader: Design, History, Economics.* London: Bloomsbury Academic.

Hill, D. (2009) *Emotionomics*. London: Kogan Page Limited.

Hill, P., Wu, X., Beadle, R. & Brown, G. (2012) *Culture and organisation.* Essex: Pearson Education Ltd.

Hinkle, D. N. (1965) *The change of personal constructs from the viewpoint of a theory of construct implications*. PhD thesis, The Ohio State University.

Hoepfl, M. C. (1997). 'Choosing qualitative research: A primer for technology education researchers', *Journal of Technology Education,* 9 (1), pp. 47-63.

Hofstede, G. & Hofstede, G. (2005) *Cultures and organisations: Software of the mind*. New York: McGraw-Hill.

Holland, R. & Lam, B. (2014) *Managing strategic design.* London: Palgrave.

Holloway, I. & Wheeler, S. (2010). *Qualitative research in nursing and healthcare*. Oxford: Wiley-Blackwell.

Hove, S. E. & Anda, B. (2005) 'Experiences from conducting semi-structured interviews in empirical software engineering research', *Software metrics, 2005. 11th ieee international symposium*. IEEE, September 19-22.

Hugentobler, H. K. (2017). 'Hacking the organization: Organizational Transformation by Design', *The Design Journal,* 20 (1), pp. S522-S530.

Humphrey, W. S. (1987) 'Characterizing the software process: a maturity framework', *IEEE software,* 5 (2), pp. 73-79.

Hunter, M. (2014) 'What is design and why it matters', [Online]. Available at: http://www.thecreativeindustries.co.uk/uk-creative-overview/news-and-views/view-what-is-design-and-why-it-matters# [Accessed: 28 June 2017].

Hyde, K. F. (2000) 'Recognising deductive processes in qualitative research', *Qualitative market research: An international journal,* 3 (2), pp. 82-90.

Iansiti, M. (1993) 'Jumping the product generation gap', *Harvard Business Review,* 71 (3), pp. 138-147.

Innovate Uk. (2018) *Knowledge Transfer Partnerships*. Available: http://ktp.innovateuk.org [Accessed: 2 April 2018].

Jankowicz, A. (2005) *Business Research Projects.* London: Thomson Learning.

Jankowicz, D. (2004) *The easy guide to repertory grids.* London: John Wiley & Sons.

Jeffs, C. (2008) *Strategic management*. London: Sage Publications.

Jenkins, J. (2009) 'Creating the right environment for design', In Lockwood, T. (ed.) *Design thinking.* New York: Allworth Press.

John, W. S. & Johnson, P. (2000). 'The pros and cons of data analysis software for qualitative research', *Journal of nursing scholarship,* 32 (4), pp. 393-397.

Johnson, P. & Duberley, J. (2000) *Understanding management research*. London: Sage Publications.

Jokela, T. (2004) 'Evaluating the user-centredness of development organisations: conclusions and implications from empirical usability capability maturity assessments', *Interacting with Computers,* 16 (6), pp. 1095-1132.

Jonas, W. (2007) 'Design Research and its Meaning to the Methodological Development of the Discipline', *Design research now*, pp. 187-206.

Jones, J. C. (1991) *Designing designing*. London: Architecture Design and Technology Press.

Jones, J. C. (1992). *Design methods.* 2nd edn. London:John Wiley & Sons.

Jones, R. & Noble, G. (2007) 'Grounded theory and management research: a lack of integrity?', *Qualitative Research in Organizations and Management: An International Journal,* 2 (2), pp. 84-103.

Junginger, S. & Sangiorgi, D. (2009) 'Service design and organizational change: Bridging the gap between rigour and relevance', *Proceedings of the 3rd IASDR Conference on Design Research*. South Korea:Korean Society of Design Science Seoul, pp. 4339-4348.

Kahn, R. L. & Cannell, C. F. (1957) *The dynamics of interviewing; theory, technique, and cases*. New York: John Wiley.

Kanno, Y. & Shibata, S. (2013) 'Organizational factors in the product design development process', *International Journal of Business and Management,* 8 (1), pp. 15-26.

Kelly, G. (1955) *The psychology of personal constructs*. New York: Norton.

Kelly, T. & Littman, J. (2001) *The art of innovation: Lessons in creativity from IDEO America's leading design firm*. New York: Currency Doubleday.

Kemmis, S. & Mctaggart, R. (2003) 'Participatory action research', In Denzin, N. & Lincoln, Y. (ed.) *Strategies for qualitative enquiry*. (2nd ed). Thousand Oaks: Sage Publications.

Kidder, L. & Selltiz, C. (1981) *Selltiz, Wrightsman, and Cook's Research methods in social relations*. New York: Holt, Rinehart and Winston.

Kiernan, L. & Ledwith, A. (2014) 'Is design education preparing product designers for the real world? A study of product design graduates in Ireland', *The Design Journal*, 17 (2), pp. 218-237.

Kimbell, L. (2011) 'Rethinking design thinking: Part 1', *Design and Culture*, 3 (3), pp. 285-306.

Kitchin, R. & Tate, N. (2000) *Conducting research into human geography: Theory, methodology and practice*. London: Prentice Hall.

Koch, T. (2006). 'Establishing rigour in qualitative research: the decision trail', *Journal of advanced nursing,* 53 (1), pp. 91-100.

Kolko, J. (2010) 'Abductive thinking and sensemaking: The drivers of design synthesis', *Design Issues,* 26 (1), pp. 15-28.

Kolko, J. (2015) 'Design thinking comes of age', *Harvard Business Review* [Online]. Available: https://hbr.org/2015/09/design-thinking-comes-of-age (Accessed: 1 September 2015).

Koskinen, I., Zimmerman, J., Binder, T., Redstrom, J. & Wensveen, S. (2011). *Design research through practice: From the lab, field, and showroom.* Massachusetts: Morgan Kaufmann.

Kotabe, M., Srinivasan, S. S. & Aulakh, P. S. (2002) 'Multinationality and firm performance: The moderating role of R&D and marketing capabilities', *Journal of international business studies*, 33 (1), pp. 79-97.

Kovačević, A. (2008) ‘Competence development in an international product design course’, *Proceedings from Design 2008, The 10th International Design Conference.* Dubrovnik, Croatia.

Kretzschmar, A. (2003) *The economic effects of design*. Available at: https://erhvervsstyrelsen.dk/sites/default/files/the_economic_effects_of_designn.pdf (Accessed: 6 April 2018).

Krippendorff, K. (1989) ‘On the essential contexts of artefacts or on the proposition that design is making sense (of things)’, *Design Issues,* 5 (2), pp. 9-39.

Krippendorff, K. (2004) *Content analysis: An introduction to its methodology*. Thousand Oaks: Sage Publications.

Kurasaki, K. S. (2000) ‘Intercoder reliability for validating conclusions drawn from open-ended interview data’, *Field methods,* 12 (3), pp. 179-194.

Kuznets, S. (1965) *Economic growth and structure*. London: Heinemann Educational Books.

Kyffin, S. & Gardien, P. (2009) ‘Navigating the Innovation Matrix: An Approach to Design-led Innovation’, *International Journal of Design*, 3 (1), pp. 57-69.

Lahrmann, G., Marx, F., Mettler, T., Winter, R. & Wortmann, F. (2011) Inductive design of maturity models: applying the Rasch algorithm for design science research. In Jain, H., Sinha, A.P., & Vitharana, P. (ed) Service-Oriented perspectives in Design Science Research. DESRIST 2011. Lecture notes in computer science, Berlin: Springer, pp. 176-191.

Leonard−Barton, D. (1992) ‘Core capabilities and core rigidities: A paradox in managing new product development’, *Strategic management journal,* 13 (1), pp. 111-125.

Leonard-Barton, D. (1995) *Wellsprings of knowledge: Building and sustaining the sources of innovation*. Boston: Harvard Business School Press.

Lester, R. & Piore, M. (2004) *Innovation: The missing dimension*. Cambridge: Harvard University Press.

Levy, A. (1986) ‘Second-order planned change: Definition and conceptualization’, *Organizational dynamics,* 15 (1), pp. 519-1723.

Liu, S. X. & De Bont, C. (2017) ‘Barriers to Strategic Design: A Perspective from China’, *She Ji: The Journal of Design, Economics, and Innovation,* 3 (2), pp. 133-145.

Locke, K. (2001) *Grounded theory in management research*. London: Sage Publications.

Lockwood, T. (2009) *Design thinking: Integrating innovation, customer experience, and brand value.* New York: Allworth Press.

Louis, M. (1985) ‘An investigator's guide to workplace culture’, In Frost, P., Moore, L., Louis, M., Lundberg, C. & Martin, J. (ed.) *Organizational Culture.* Beverly Hills: Sage Publications.

Louis, M. R. (1980) Surprise and sense making: What newcomers experience in entering unfamiliar organizational settings. *Administrative science quarterly*, 25 (2), pp. 226-251.

Louise-Barriball, K. & While, A. (1994) ‘Collecting Data using a semi−structured interview: a discussion paper’, *Journal of advanced nursing,* 19 (2), pp. 328-335.

Luchs, M. & Swan, K. S. (2011) ‘Perspective: The emergence of product design as a field of marketing inquiry’, *Journal of Product Innovation Management,* 28 (3), pp. 327-345.

Luo, X., Slotegraaf, R. J. & Pan, X. (2006) ‘Cross-functional “coopetition”: The simultaneous role of cooperation and competition within firms’, *Journal of Marketing,* 70 (2), pp. 67-80.

Lutters, E., Van Houten, F. J., Bernard, A., Mermoz, E. & Schutte, C. S. (2014) ‘Tools and techniques for product design’, *CIRP Annals-Manufacturing Technology,* 63 (2), pp. 607-630.

Manzini, E. (2011) ‘Design schools as agents of (sustainable) change’, *The 1st international symposium Cummulus/DRS for design education researchers*. Paris.

Manzini, E. (2014) ‘Making things happen: Social innovation and design’, *Design Issues,* 30 (1), pp. 57-66.

Marshall, C. & Rossman, G. (2006) *Designing qualitative research.* Thousand Oaks: Sage Publications.

Martin, R. (2009) *The design of business: Why design thinking is the next competitive advantage*. Massachusetts: Harvard Business School Publishing.

Martins, E. C. & Terblanche, F. (2003) 'Building organisational culture that stimulates creativity and innovation', *European Journal of Innovation Management,* 6 (1), pp. 64-74.

Maslow, A. (1954) *Motivation and personality*. New York: Harper.

Mathers, J. (2015) *Defining design: going beyond disciplines.* [Online]. Available: http://www.designcouncil.org.uk/news-opinion/defining-design-going-beyond-disciplines (Accessed: 20 August 2015).

Mathur, G., Jugdev, K. & Shing Fung, T. (2007) 'Intangible project management assets as determinants of competitive advantage', *Management Research News,* 30 (7), pp. 460-475.

Matthews, J. H. & Bucolo, S. (2011) 'Do programs to improve business performance in small and medium manufacturing enterprise improve opportunity recognition?', In Maritz, A (ed). *Regional Frontiers 2011*, Victoria: Swinburne University of Technology, pp. 999-1009.

Mcgrath, M. (1996) *Setting the pace in product development: A guide to product and cycle-time excellence*. Boston: Elsevier.

Mclafferty, E. & Farley, A. (2006). 'Analysing qualitative research data using computer software', *Nursing Times',* 102 (24), pp. 34-36.

Melander, C. (2015) *Danish design support programmes: Developing the design skills of danish businesses.* [Online]. Design For Europe. Available: http://designforeurope.eu/case-study/danish-design-support-programmes (Accessed: 22 June 2017).

Meschi, P.-X. & Roger, A. (1994) 'Cultural Context and Social Effectiveness in International Joint Ventures', *MIR: Management International Review,* 34 (3), pp. 197-215.

Meyer, S. B. & Lunnay, B. (2013) 'The application of abductive and retroductive inference for the design and analysis of theory-driven sociological research', *Sociological Research Online,* 18 (1), pp. 1-11.

Michlewski, K. (2006) *Towards an understanding of the role the culture of designers can play in organisations*. PhD thesis, Northumbria University.

Michlewski, K. (2008) 'Uncovering design attitude: Inside the culture of designers', *Organisation Studies*, 29 (3), pp. 373-392.

Michlewski, K. (2015) *Design Attitude*. New York: Routledge.

Miles, M. & Huberman, H. (1994) *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks: Sage Publications.

Miles, M., Huberman, H. & Saldaña, J. (2014) *Qualitative data analysis: A methods sourcebook.* Thousand Oaks: Sage Publications.

Miller, K. & Moultrie, J. (2013) 'Understanding the skills of design leaders', *Design Management Journal*, 8 (1), pp. 35-51.

Miller, S. (2016) *Measuring the use of design across Europe.* [Online]. The UK Design Council. Available: http://www.designcouncil.org.uk/news-opinion/measuring-use-design-across-europe (Accessed: 22 June 2017).

Mintzberg, H. (1979) 'An Emerging Strategy of "Direct" Research', *Administrative Science Quarterly,* 24 (4), pp. 582-589.

Moultrie, J. & Livesey, F. (2009) *International design scoreboard: initial indicators of international design capabilities*. Cambridge: IFM Management Technology Policy.

Moultrie, J., Nilsson, M., Dissel, M., Haner, U. E., Janssen, S. & Van Der Lugt, R. (2007) 'Innovation spaces: Towards a framework for understanding the role of the physical environment in innovation', *Creativity and Innovation Management,* 16 (1), pp. 53-65.

Mumford, T., Campion, M. & Morgeson, F. (2007) 'The leadership skills strataplex: Leadership skill requirements across organisational levels', *The leadership Quarterly*, 18 (2), pp. 153-166.

Myerson, J. & Ross, P. (1999) *The Creative Office.* London: Laurence King.

Myerson, J. & Ross, P. (2003) *The 21st century office.* London: Laurence King Publishing Ltd.

Nelson, K., Clarke, J. & Stoodley, I. (2014) ‘An exploration of the Maturity Model concept as a vehicle for higher education institutions to assess their capability to address student engagement: A work in progress’, *Ergo,* 3 (1), pp. 29-36.

Nightingale, D. J. & Cromby, J. (2002) ‘Social constructionism as ontology: Exposition and example’, *Theory & Psychology,* 12 (5), pp. 701-713.

Nili, A., Tate, M. & Barros, A. (2017). ‘A critical analysis of inter-coder reliability methods in information systems research’, *Australasian Conference on Information Systems*. Hobart, Australia.

Nonaka, I. & Takeuchi, H. (1995) *The knowledge creating company.* Oxford: Oxford University Press.

Norman, D. (2013) *The design of everyday things: Revised and expanded edition*. New York: Basic Books.

Norman, D. A. & Verganti, R. (2014) ‘Incremental and radical innovation: Design research vs. technology and meaning change’, *Design Issues,* 30 (1), pp. 78-96.

Nussbaum, B., Berner, R. & Brady, D. (2005) ‘Get Creative! How to build innovative companies’, *Bloomberg Business Week*, pp. 60-68.

Oyegoke, A. (2011) ‘The constructive research approach in project management research’, *International Journal of Managing Projects in Business,* 4 (4), pp. 573-595.

Pallister, J. (2015) *The secrets of the chief design officer* [Online]. UK Design Council. Available: http://www.designcouncil.org.uk/news-opinion/secrets-chief-design-officer-0 [Accessed: 10 July 2017].

Pascale, R. (1985) ‘The paradox of “corporate culture”: Reconciling ourselves to socialization’, *California Management Review,* 27 (2), pp. 26-41.

Paulk, M. C., Curtis, B., Chrissis, M. B. & Weber, C. V. (1993) ‘Capability maturity model, version 1.1’, *IEEE software,* 10 (4), pp. 18-27.

Perlow, L. A. (1999) ‘The time famine: Toward a sociology of work time’, *Administrative science quarterly,* 44 (1), pp. 57-81.

Perry, C. (1998) ‘Processes of a case study methodology for postgraduate research in marketing’, *European journal of marketing,* 32 (9/10), pp. 785-802.

Peteraf, M. A. (1993) ‘The cornerstones of competitive advantage: A resource−based view’, *Strategic management journal,* 14 (3), pp. 179-191.

Pettigrew, D. K., Thurgood, C. & Bucolo, S. (2016) ‘A Design Innovation Adoption Tool for SMEs’, *20th DMI: Academic Design Management Conference, Inflection Point: Design Research Meets Design Practice*. Boston:DMI. 28-29 July.

Piaget, J. (1980) ‘The psychogenesis of knowledge and its epistemological significance’, In Piattelli-Palminarini, M. (ed.) *Language and Learning.* Cambridge: Harvard University Press.

Pine, J. & Gilmore, J. (1999) *The experience economy,* Boston: Harvard Business School Press.

Planview. (2013) ‘A new framework for assessing your innovation programme: Introducing the innovation management maturity model by Planview’, [Online]. Available: http://www2.planview.com/im3/docs/Planview-Innovation-Maturity-Model.pdf (Accessed: 26 June 2017).

Polanyi, M. (1958) *Personal knowledge: Towards a post-critical philosophy.* Chicago: University of Chicago Press.

Popadiuk, S. & Choo, C. W. (2006) ‘Innovation and knowledge creation: How are these concepts related?’, *International Journal of Information Management,* 26 (4), pp. 302-312.

Pöppelbuß, J. & Röglinger, M. (2011) ‘What makes a useful maturity model? a framework of general design principles for maturity models and its demonstration in business process management’, *ECIS 2011 proceedings*. Available at: http://aisel.aisnet.org/ecis2011/28/ (Accessed: 9 April 2018).

Porter, M. (1992) *The competitive advantage of nations*. London: Macmillan Press.

Pugh, S. (1990) *Total design: Integrated methods for successful product engineering*. Harlow: Pearson Education.

Rae, J. (2015) 'Design Value Index’, *Design Management Review,* 26 (1), pp. 4-8.

Rahm, E. & Do, H. H. (2000) ‘Data cleaning: Problems and current approaches’, *IEEE Computer Society Bulletin of the Technical Committee on Data Engineering,* 23 (4), pp. 3-13.

Ralph, P. & Wand, Y. (2009) ‘A Proposal for a Formal Definition of the Design Concept’. In Lyytinen, K., Loucopoulos, P., Mylopoulous, J. & Robinson, B. (ed.) *Design Requirements Engineering: A Ten-Year Perspective.* Berlin: Springer.

Ravasi, D. & Stigliani, I. (2012) 'Product design: A review and research agenda for management studies’, *International Journal of Management Reviews,* 14 (4), pp. 464-488.

Reichertz, J. (2004) ‘Abduction, deduction and induction in qualitative research’, In Flick, U., Von Kardorff, E. & Steinke, I. (ed.) *A companion to qualitative research.* London: Sage Publications.

Reuveni, Y. & Vashdi, D. R. (2015) ‘Innovation in multidisciplinary teams: The moderating role of transformational leadership in the relationship between professional heterogeneity and shared mental models’, *European Journal of Work and Organizational Psychology,* 24 (5), pp. 678-692.

Richards, L. (1993) ‘Writing a qualitative thesis or grant application’, In Beattie, K. (ed.) *So where's your research profile?* South Melbourne: Union of Australian College Academics.

Rittel, H. W. (1967) ‘Free for All’. In West Churchman, C. *Management Science*, 14 (4), pp. 141-146.

Rittel, H. W. & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy sciences,* 4 (2), pp. 155-169.

Robinson, V. M. (2010) ‘From instructional leadership to leadership capabilities: Empirical findings and methodological challenges’, *Leadership and Policy in Schools,* 9 (1), pp. 1-26.

Røise, Ø., Edeholt, H., Morrison, A., Bjørkli, C. & Hoff, T. (2014) ‘What we talk about when we talk about design’, *FORMakademisk*, 7 (2), pp. 1-17.

Rothwell, R. (1992) ‘Successful industrial innovation: critical factors for the 1990s’, *R&d Management,* 22 (3), pp. 221-240.

Rubenstein, A. H., Chakrabarti, A. K., O'keefe, R. D., Souder, W. E. & Young, H. (1976) 'Factors influencing innovation success at the project level', *Research management,* 19 (3), pp. 15-20.

Rusk, M. (2016) 'Translational design: The evolution of design management for the twenty-first century', In: Junginger, S. & Faust, J. (ed.) *Designing Business and Management.* London: Bloomsbury Academic, pp 185-196.

Russell, C. K. & Gregory, D. M. (1993) 'Issues for consideration when choosing a qualitative data management system', *Journal of Advanced Nursing,* 18 (11), pp. 1806-1816.

Rust, C., Mottram, J. & Till, J. (2007). *Review of practice-led research in art, design and architecture*. [Online]. Available at: http://shura.shu.ac.uk/7596/1/Pactice-ledReviewNov07.pdf (Accessed: 9 April 2018).

Ryan, G. (1999) 'Measuring the typicality of text: Using multiple coders for more than just reliability and validity checks', *Human Organization,* 58 (3), pp. 313-322.

Saldaña, J. (2016) *The coding manual for qualitative researchers*. London: Sage Publications.

Salter, A. & Gann, D. (2003) 'Sources of ideas for innovation in engineering design', *Research policy,* 32 (8), pp. 1309-1324.

Salvador, T., Bell, G. & Anderson, K. (1999) 'Design Ethnography', *Design Management Journal (Former Series),* 10 (4), pp. 35-41.

Sandelowski, M. (1986) 'The problem of rigor in qualitative research', *Advances in nursing science*, 8 (3), pp. 27-37.

Sander, P. & Brombacher, A. (2000) 'Analysis of quality information flows in the product creation process of high-volume consumer products', *International Journal of Production Economics,* 67 (1), pp. 37-52.

Sangiorgi, D. (2011) 'Transformative services and transformation design', *International Journal of Design,* 5 (2), pp. 29-40.

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students* (5th ed). London: Pearson Education Limited.

Schein, E. (1985) *Organisational Culture and Leadership*. San Francisco: Jossey-Bass.

Schein, E. (1990) 'Organizational culture', *American Psychologist,* 42 (1), pp. 109-119.

Schön, D. (1991). *The reflective practitioner: How professionals think in action*, Aldershot: Ashgate Publishing Limited.

Seidel, J. (1991) 'Method and madness in the application of computer technology to qualitative data analysis', In Fielding, N. & Lee, R. (ed.) *Using computers in qualitative research*. London: Sage Publications.

Seidel, V. P. & Fixson, S. K. (2013). 'Adopting design thinking in novice multidisciplinary teams: The application and limits of design methods and reflexive practices', *Journal of Product Innovation Management,* 30 (1), pp. 19-33.

Senge, P. M. (1990) *The art and practice of the learning organisation*. New York: Doubleday Currency.

Sevaldson, B. (2010) Discussions & movements in design research. *FORMakademisk,* 3 (1), pp. 8-35.

Shakir, M. (2002) 'The selection of case studies: strategies and their applications to IS implementation case studies', *Research Letters in the Information and Mathematical Sciences*, 3 (1), pp. 69-77.

Silverman, D. (2000) *Doing qualitative research: A practical handbook*. London: Sage Publications.

Simon, H. A. (1955) 'A behavioral model of rational choice', *The quarterly journal of economics*, 69 (1), pp.99-118.

Simon, H. A. (1969). *The sciences of the artificial*. Cambridge: MIT press.

Simon, H. A. (1996) *The sciences of the artificial*. 3rd edn. Massachusetts: MIT press.

Simpson, J. & Weiner, E. (1989) *The Oxford English Dictionary.* Oxford: Oxford University Press.

Smith, E. A. (2001) 'The role of tacit and explicit knowledge in the workplace', *Journal of knowledge Management,* 5 (4), pp. 311-321.

Sobh, R. & Perry, C. (2006) ‘Research design and data analysis in realism research’, *European Journal of marketing,* 40 (11/12), pp. 1194-1209.

Soiferman, L. K. (2010) *Compare and Contrast Inductive and Deductive Research Approaches*. [Online] Available at: https://eric.ed.gov/?id=ED542066 (Accessed: 9 April 2018).

Sørensen, H. (2015) Development of an innovation process for managing employee-driven innovation. PhD Thesis, Aalborg University.

Stacey, R. D., Griffin, D. & Shaw, P. (2000) *Complexity and management: fad or radical challenge to systems thinking?* London: Routledge.

Stake, R. (1995) *The art of case study research*. Thousand Oaks: Sage Publications.

Stanford Encyclopaedia of Philosophy. (2017) *Abduction* [Online]. Available: https://plato.stanford.edu/entries/abduction/ (Accessed: 9 August 2017).

Steinberg, M. (2010) *Design policy: A perspective from Finland*. [Conference presentation] Helsinki Global Design Lab, 2010.

Steinø, N. & Markussen, T. (2011) ‘Design research between design and research’, *The 2011 symposiym of the Nordic Association of Architectural Research.* Aarhus School of Architecture.

Straker, K. & Wrigley, C. (2016) ‘The role of emotion, experience and meaning: the comparative case of Apple and Samsung’, In: DeFillippi, R., Rieple, A. & Wikström, P. (ed.) *International Perspectives on Business Innovation and Disruption in Design.* Cheltenham: Edward Elgar Publishing Inc.

Swann, C. (2002) ‘Action research and the practice of design’, *Design Issues,* 18 (1), pp. 49-61.

Talke, K., Salomo, S., Wieringa, J. E. & Lutz, A. (2009) ‘What about design newness? Investigating the relevance of a neglected dimension of product innovativeness’, *Journal of product innovation management,* 26 (6), pp. 601-615.

Tellis, W. M. (1997) ‘Results of a case study on information technology at a university’, *The qualitative report,* 3 (4), pp. 1-25.

Tesluk, P. E., Farr, J. L. & Klein, S. R. (1997) ‘Influences of Organizational Culture and Climate on Individual Creativity’, *The Journal of Creative Behavior,* 31 (1), pp. 27-41.

Tether, B. (2005) *Think piece on: The role of design in business performance*. [Online]. Available at: http://citeseerx.ist.psu.edu/viewdoc/download;jsessionid=88B96AFD527F79FF271E783 EB013950E?doi=10.1.1.101.7929&rep=rep1&type=pdf (Accessed: 9 April 2018).

Thomas, D. (2006) ‘A general inductive approach for analyzing qualitative evaluation data’, *American Journal of Evaluation,* 27 (2), pp. 237-246.

Tofan, D., Galster, M. & Avgeriou, P. (2011) Capturing tacit architectural knowledge using the repertory grid technique (NIER track). *Proceedings of the 33rd International Conference on Software Engineering*. Honolulu, 21-28 May.

Topalian, A. (2005) ‘Design frontline’, *Newsletter of the Design Leadership Forum*. July 2005.

Trochim, W. (2006) *The research methods knowledge base* [Online]. Available: http://www.socialresearchmethods.net/kb/ (Accessed: 15 September 2015).

Tushman, M. & O'reilly, C. (1997) *Winning through innovation: A practical guide to leading organisational change and renewal*. Massachusetts: Harvard Business School Press.

Uk Design Council. (2012) *Design delivers for business: A summary of evidence from the Design Council's leadership programme*. Available at: https://www.designcouncil.org.uk/sites/default/files/asset/document/DesignDelivers%20for%20Business%20briefing.pdf (Accessed: 6 April 2018).

Uk Design Council. (2017) *Design: Delivering a new approach to growth*. Available at: https://www.designcouncil.org.uk/sites/default/files/asset/document/Design%20Council%20Response%20to%20Industrial%20Strategy%20Green%20Paper%202017.pdf (Accessed: 6 April 2018).

University of Southern Denmark (2014) *Design capacity model*. Available: http://www.cdcm.dk/wp-content/uploads/2015/03/DKM-folder_UK_CMYK_sider-to-og-to.pdf (Accessed: 7 August 2018).

Verganti, R. (2003) ‘Design as brokering of languages: Innovation strategies in Italian firms’, *Design Management Review,* 14 (3), pp. 34-42.

Verganti, R. (2009) *Design-driven innovation: Changing the rules of competition by radically innovating what things mean.* Massachusetts: Harvard Business School Publishing Corporation.

Verganti, R. & Öberg, Å. (2013) 'Interpreting and envisioning—A hermeneutic framework to look at radical innovation of meanings', *Industrial Marketing Management,* 42 (1), pp. 86-95.

Voss, J. (1989) 'Problem-solving and the educational process', In Lesgold, A. & Glaser, K. (ed.) *Foundations for a psychology of education.* Hillsdale: Lawrence Erlbaum.

Wagner, J. & Watch, D. (2017) 'Innovation spaces: The new design of work', *Brookings* [Online] Available at: https://www.brookings.edu/research/innovation-spaces-the-new-design-of-work/ (Accessed 9 April 2018).

Ward, A., Runcie, E. & Morris, L. (2009) 'Embedding innovation: Design thinking for small enterprises', *Journal of Business Strategy,* 30 (2-3), pp. 78-84.

Warwick, L. (2015). *Can design effect transformational change in the voluntary community sector?* PhD thesis. Northumbria University.

Webster, J. & Watson, R. T. (2002). 'Analyzing the past to prepare for the future: Writing a literature review', *MIS quarterly*, 26 (2), pp. xiii-xxiii.

Weele, A. J. & Raaij, E. M. (2014) 'The future of purchasing and supply management research: About relevance and rigor', *Journal of Supply Chain Management,* 50 (1), pp. 56-72.

Westacott, E. (2017) *Relativism* [Online]. Available: http://www.iep.utm.edu/relativi/ (Accessed 17 August 2017).

Westcott, M., Sato, S., Mrazek, D., Wallace, R., Vanka, S., Bilson, C. & Hardin, D. (2013) 'The DMI Design Value Scorecard: A New Design Measurement and Management Model', *Design Management Review,* 24 (4), pp. 10-16.

Whicher, A., Raulik−Murphy, G. & Cawood, G. (2011) 'Evaluating design: Understanding the return on investment', *Design Management Review,* 22 (2), pp. 44-52.

Wolff, F. & Amaral, F. (2008) ‘Toward a Brazilian scale to measure performance by design management: two case studies’, *Proceedings of The International DMI Education Conference, Design Thinking: New Challenges for Designers, Managers and Organizations*, France. 14-15 April.

Wolff, F., Capra, A., Dutra, F. & Mozota, B. B. D. (2016) ‘Double-Loop Design Management Model’, *20th DMI: Academic Design Management Conference, Inflection Point: Design Research Meets Design Practice*. Boston:DMI. 28-29 July.

WRAP. (2017) *WRAP and the circular economy.* Available: http://www.wrap.org.uk/about-us/about/wrap-and-circular-economy (Accessed: 2 April 2018).

Wrigley, C. (2017) ‘Principles and practices of a design-led approach to innovation’, *International Journal of Design Creativity and Innovation,* 5 (3-4), pp. 235-255.

Yin, R. (2012) *Applications of case study research.* 3rd edn. Thousand Oaks: Sage Publications.

Yin, R. (2014) *Case study research: Design and methods.* Thousand Oaks: Sage Publications.

Young, R. A. (2008) ‘An integrated model of designing to aid understanding of the complexity paradigm in design practice’, *Futures,* 40 (6), pp. 562-576.

Zimmerman, J., Forlizzi, J. & Evenson, S. (2007) ‘Research through design as a method for interaction design research in HCI’, *Proceedings of the SIGCHI conference on Human factors in computing systems.* California. 28 April - 3 May.

Zurlo, F. & Cautela, C. (2014) ‘Design strategies in different narrative frames’, *Design Issues,* 30 (1), 19-35.

Zwicker, J., Fettke, P. & Loos, P. (2012) ‘The six core elements of business process management’, In Vom Brocke, J. & Rosemann, M. (ed.) *Handbook on Business Process Management.* Berlin, Germany: Springer.

Bibliography

Acklin, C. (2010) ‘Design−Driven Innovation Process Model’, Design Management Journal, 5 (1), pp. 50-60.

Adams, E. (2013) ‘The Elements and Principles of Design: A Baseline Study’, International Journal of Art & Design Education, 32 (2), pp. 157-175.

Adams, J., Hyde, W. & Murray, B. (2013) ‘Design education: International perspectives and debates’, International Journal of Art & Design Education, 32 (2), pp. 142-145.

Aftab, M., Bailey, M., Jeffs, C. & Spencer, N. (2015) ‘Three stages of learning: Team based reflection for improvement in performance of multidisciplinary teams’, *International Journal of Design Education*, 8 (3-4), pp. 1-17.

Ahmed, S. (2005) ‘Encouraging reuse of design knowledge: a method to index knowledge’, *Design Studies*, 26 (6), pp. 565-592.

Al−Karasneh, S. M. (2014) ‘Reflective Journal Writing as a Tool to Teach Aspects of Social Studies’, *European Journal of Education*, 49 (3), pp. 395-408.

Ali, A. K. (2005) ‘Using the Delphi technique to search for empirical measures of local planning agency power’, *The Qualitative Report*, 10 (4), pp. 718-744.

Armenakis, A. A., Harris, S. G. & Mossholder, K. W. (1993) ‘Creating readiness for organizational change’, *Human relations*, 46 (6), pp. 681-703.

Augier, M. & Vendelø, M. T. (1991) ‘Networks, cognition and management of tacit knowledge’, Journal of Knowledge Management, 3 (4), pp. 252-261.

Banister, P., Bunn, G., Bruman, E., Daniels, J., Duckett, P., Goodley, D., Lawthom, R., Parker, I., Runswick-Cole, K., Sixsmith, J., Smailes, S., Tindall, C. & Whelan, P. (2011). *Qualitative Methods in Psychology: A Research Guide*. Berkshire: Open University Press.

Baregheh, A., Rowley, J. & Sambrook, S. (2009) ‘Towards a multidisciplinary definition of innovation’, *Management decision*, 47 (7), pp. 1323-1339.

Baum, F., Macdougall, C. & Smith, D. (2006) ‘Participatory action research’, *Journal of Epidemiology & Community Health*, 60 (10), pp. 854-857.

Becker, H. S. (1958) ‘Problems of Inference and Proof in Participant Observation’, *American Sociological Review*, 23 (6), pp. 652-660.

Benner, P. (2004) ‘Using the Dreyfus model of skill acquisition to describe and interpret skill acquisition and clinical judgment in nursing practice and education’, *Bulletin of science, technology & society*, 24 (3), pp. 188-199.

Berge, Z., Verneil, M. D., Berge, N., Davis, L. & Smith, D. (2002) ‘The increasing scope of training and development competency’, *Benchmarking: An International Journal*, 9 (1), pp. 43-61.

Biloslavo, R. (2005) ‘Use of the knowledge management framework as a tool for innovation capability audit’, *International Journal of Innovation and Learning*, 2 (4), pp. 402-424.

Birkinshaw, J., Healey, M. P., Suddaby, R. & Weber, K. (2014) ‘Debating the future of management research’, *Journal of Management Studies*, 51 (1), pp. 38-55.

Björklund, T. A. (2013) ‘Initial mental representations of design problems: Differences between experts and novices’, Design Studies, 34 (2), pp. 135-160.

Black, A. L. & Halliwell, G. (2000) ‘Accessing practical knowledge: how? why? Teaching and teacher education’, 16 (1), pp. 103-115.

Boland Jr, R. J., Collopy, F., Lyytinen, K. & Yoo, Y. (2008) ‘Managing as designing: lessons for organization leaders from the design practice of Frank O. Gehry’, Design Issues, 24 (1), pp. 10-25.

Bolton, G. (2014) *Reflective practice: Writing and professional development*. London: Sage Publications.

Bonjour, L. (1985) *The structure of empirical knowledge*. London: Cambridge University Press.

Bridgstock, R. (2013) ‘Professional Capabilities for Twenty-First Century Creative Careers: Lessons from Outstandingly Successful Australian Artists and Designers’, International Journal of Art & Design Education, 32, pp. 176-189.

Brown, R. B. & Mccartney, S. (1995) ‘Competence is not enough: meta-competence and accounting education’, *Accounting Education*, 4 (1), pp. 43-53.

Brown, T. (2015) When Everyone Is Doing Design Thinking, Is It Still a Competitive Advantage? Available: https://hbr.org/2015/08/when-everyone-is-doing-design-thinking-is-it-still-a-competitive-advantage? (Accessed: 1 September 2015).

Bucciarelli, L. L. (2003) 'Designing and learning: a disjunction in contexts', *Design Studies*, 24 (3), pp. 295-311.

Buchanan, R. (1992) 'Wicked problems in design thinking', *Design Issues*, 8 (2), pp. 5-21.

Budge, K., Beale, C. & Lynas, E. (2013) 'A Chaotic Intervention: Creativity and Peer Learning in Design Education', *International Journal of Art & Design Education*, 32, pp. 146-156.

Butterfield, L. D., Borgen, W. A., Amundson, N. E. & Maglio, A.-S. T. (2005) 'Fifty years of the critical incident technique: 1954-2004 and beyond', *Qualitative research*, 5 (4), pp. 475-497.

Carlopio, J. (2010). *Strategy by design*. New York: Palgrave MacMillan.

Carnevale, J. J., Inbar, Y. & Lerner, J. S. (2011) 'Individual differences in need for cognition and decision-making competence among leaders', *Personality and Individual Differences*, 51 (3), pp. 274-278.

Cartwright, S. (2002) 'Double-loop learning: A concept and process for leadership educators', *Journal of Leadership Education*, 1 (1), pp. 68-71.

Cassim, F. (2013) 'Hands On, Hearts On, Minds On: Design Thinking within an Education Context', *International Journal of Art & Design Education*, 32, pp. 190-202.

Cavusgil, S. T., Calantone, R. J. & Zhao, Y. (2003) 'Tacit knowledge transfer and firm innovation capability', *Journal of Business & Industrial Marketing*, 18 (1), pp. 6-21.

Chapman, J. A. (2002) 'A framework for transformational change in organisations', *Leadership & Organization Development Journal*, 23 (1), pp. 16-25.

Charmaz, K. (1990) 'Discovering'chronic illness: Using grounded theory', *Social science & medicine*, 30 (11), pp. 1161-1172.

Cheetham, G. & Chivers, G. (1996) ‘Towards a holistic model of professional competence’, *Journal of European industrial training*, 20 (5), pp. 20-30.

Chen, L. & Li, S. (2002) ‘A computerized team approach for concurrent product and process design optimization’, *Computer-Aided Design*, 34 (1), pp. 57-69.

Chen, S. & Venkatesh, A. (2013) ‘An investigation of how design-oriented organisations implement design thinking’, *Journal of Marketing Management*, 29 (15-16), pp. 1680-1700.

Choueke, R. & Armstrong, R. (1998) ‘The learning organisation in small and medium-sized enterprises: A destination or a journey?’, *International Journal of Entrepreneurial Behavior & Research*, 4 (2), pp. 129-140.
Collins, A., Joseph, D. & Bielaczyc, K. (2004) ‘Design research: Theoretical and methodological issues’, *The Journal of the learning sciences*, 13 (1), pp. 15-42.

Conley, C. (2004) ‘Leveraging design's core competencies’, *Design Management Review*, 15 (3), pp. 45-51.

Cope, J. & Watts, G. (2000) ‘Learning by doing-An exploration of experience, critical incidents and reflection in entrepreneurial learning’, *International Journal of Entrepreneurial Behavior & Research*, 6 (3), pp. 104-124.

Daft, R. L. (2013) *Organization theory and design*. Ohio: Cengage Learning.

Damanpour, F. & Aravind, D. (2012) ‘Managerial innovation: Conceptions, processes, and antecedents’, *Management and Organization Review*, 8 (2), pp. 423-454.

Darke, J. (1979) ‘The primary generator and the design process’, *Design Studies*, 1 (1), pp. 36-44.

Daspit, J., Justice Tillman, C., Boyd, N. G. & Mckee, V. (2013) ‘Cross−functional team effectiveness’, *Team Performance Management: An International Journal*, 19 (1-2), pp. 34-56.

Davenport, T. & Prusak, L. (1998) *Working knowledge: How organisations manage what they know*. Boston: Harvard Business School Press.

Defillippi, R. J. & Arthur, M. B. (1994) ‘The boundaryless career: A competency-based perspective’, *Journal of organizational behavior*, 15 (4), pp. 307-324.

Denton, H. G. (1997) ‘Multidisciplinary team-based project work: planning factors’, *Design Studies*, 18 (2), pp. 155-170.

Dickson, P., Schneier, W., Lawrence, P. & Hytry, R. (1995) ‘Managing Design in Small High-Growth Companies’, Journal of Product Innovation Management, 12 (5), pp. 406-414.

Donaldson, B. & Mcnicholas, C. (2004) ‘Understanding the postgraduate education market for UK-based students: A review and empirical study’, *International Journal of Nonprofit & Voluntary Sector Marketing*, 9 (4), pp. 346-360.

Dong, A., Lovallo, D. & Mounarath, R. (2015) ‘The effect of abductive reasoning on concept selection decisions’, *Design Studies*, 37 (1), pp. 37-58.

Dreyfus, H. (2002) ‘Intelligence without representation – Merleau-Ponty's critique of mental representation The relevance of phenomenology to scientific explanation’, *Phenomenology and the Cognitive Sciences*, 1 (4), pp. 367-383.

Dreyfus, H. & Dreyfus, S. (1986) *Mind over machine: The power of human intuition and expertise in the era of the computer*. New York: The Free Press.

Dul, J. & Hak, T. (2008) *Case study methodology in business research*. New York: Routledge.

Eastman, C., Mccracken, M. & Newstetter, W. (2001) *Design knowing and learning: Cognition in design education*. Oxford: Elsevier Science Ltd.

Ehrlenspiel, K., Giapoulis, A. & Günther, J. (1997) ‘Teamwork and design methodology —Observations about teamwork in design education’, *Research in Engineering Design*, 9 (2), pp. 61-69.

Esgate, A. & Groome, D. (2005) *An introduction to applied cognitive psychology*. New York, USA, Psychology Press.

Filson, A. & Lewis, A. (2000) ‘Barriers between design and business strategy’, *Design Management Journal*, 11 (4), pp. 48-52.

Fleischmann, K. & Daniel, R. J. (2010) ‘Increasing authenticity through multidisciplinary collaboration in real-life scenarios in digital media design education’, *CoDesign*, 6 (2), pp. 61-74.

Flyvbjerg, B. (2005) ‘Social science that matters’, *Foresight Europe*, 2, pp. 38-42.

Ford, M. E. (1982) ‘Social cognition and social competence in adolescence’, *Developmental Psychology*, 18 (3), pp. 323-340.

Francis, D. (1995) ‘The reflective journal: A window to preservice teachers' practical knowledge’, Teaching and Teacher Education, 11 (3), pp. 229-241.

Fraser, H. M. A. (2009) ‘Designing business: New models for success’, *Design Management Review*, 20 (2), pp. 56-65.

Gemma, W. (2014) The 6 types of knowledge: From a priori to procedural [Online]. Available: https://blog.udemy.com/types-of-knowledge/ (Accessed: 10 September 2015).

Gerring, J. (2013) ‘The Case Study: What it is and What it Does’, In Goodin, R. (ed.) *The oxford handbook of political science.* New York: Oxford University Press.

Gibson, J. (2008) ‘Cognitivism and the Arts’, *Philosophy Compass,* 3 (4), pp. 573-589.

Giles, D. (2002) *Advanced research methods in psychology*. New York: Routledge.

Giloi, S. & Du Toit, P. (2013) ‘Current Approaches to the Assessment of Graphic Design in a Higher Education Context’, *International Journal of Art & Design Education*, 32, pp. 256-268.

Gladwell, M. (2008) *Outliers: The story of success*. London: Penguin Books.

Glanville, R. (1999) ‘Researching Design and Designing Research’, *Design Issues*, 15 (2), pp. 80-91.

Godbout, A. J. (2000) ‘Managing core competencies: the impact of knowledge management on human resources practices in leading-edge organizations’, *Knowledge and Process Management,* 7 (2), pp. 76-86.

Goodfellow, J. (2000). ‘Knowing from the inside: Reflective conversations with and through the narratives of one cooperating teacher’, *Reflective practice*, 1 (1), pp. 25-42.

Gorb, P. & Dumas, A. (1987). ‘Silent Design’, *Design Studies*, 8 (3), pp. 150-156.

Greenwood, J. (1998) ‘The role of reflection in single and double loop learning’, *Journal of advanced nursing*, 27 (5), pp. 1048-1053.

Hardin, D., Westcott, M. & Berno, T. (2014) ‘Redesigning graduate education’, *Design Management Review*, 25 (1), pp. 12-21.

Hassenzahl, M. & Wessler, R. (2000) ‘Capturing design space from a user perspective: The repertory grid technique revisited’, *International Journal of Human-Computer Interaction*, 12 (3-4), pp. 441-459.

Heller, F. A. (1969). ‘Group feedback analysis: A method of field research’, *Psychological Bulletin*, 72 (2), pp. 108-117.

Heylighen, A. & Nijs, G. (2014) ‘Designing in the absence of sight: Design cognition re-articulated’, *Design Studies*, 35 (2), pp. 113-132.

Hlaoittinun, O., Bonjour, E. & Dulmet, M. 2008. ‘A multidisciplinary team building method based on competency modelling in design project management’, *International Journal of Management Science and Engineering Management*, 3 (3), pp. 163-175.

Hollenbeck, G. P., Mccall, M. W. & Silzer, R. F. (2006) ‘Leadership competency models’, *The Leadership Quarterly*, 17, pp. 398-413.

Holsapple, C. W. & Joshi, K. D. (2002) ‘Knowledge manipulation activities: results of a Delphi study’, *Information & Management*, 39, pp. 477-490.

Hussein, M. E., Hirst, S., Salyers, V. & Osuji, J. (2014) ‘Using grounded theory as a method of inquiry: Advantages and disadvantages’, *The Qualitative Report*, 19 (27), pp. 1-15.

Jahnke, M. & Johansson-Sköldberg, U. (2014) ‘Introducing design-driven innovation: A challenging role towards new possibilities’, In: Graen, G. (ed.) *Millennial spring: Designing the future of organizations*. Charlotte: Information Age Publishing.

Jerrard, B., Smith, M. & Johnstone, I. (2013) 'Applied Research and Knowledge Transfer: Retaining Design Knowledge Assets in Higher Education’, *The Design Journal*, 16 (3), pp. 339-355.

Jonassen, D. H. (2000) ‘Toward a design theory of problem solving’, *Educational Technology Research and Development*, 48 (4), pp. 63-85.

Jordan, M. E., Kleinsasser, R. C. & Roe, M. F. (2014) ‘Wicked problems: inescapable wickedity’, *Journal of Education for Teaching*, 40 (4), pp. 415-430.

Jozaisse, F.(2011) ‘Design leadership: Current limits and future opportunities’, In: Cooper, R., Junginger, S. & Lockwood, T. (eds.) *The handbook of design management*. Oxford: Berg.

Junginger, S. (2007) ‘Learning to design: giving purpose to heart, hand and mind’, *Journal of Business Strategy*, 28 (4), pp. 59-65.

Junginger, S. (2008) ‘Product development as a vehicle for organizational change’, *Design Issues*, 24 (1), pp. 26-35.

Kaufmann, A. & Tödtling, F. (2002) ‘How effective is innovation support for SMEs? An analysis of the region of Upper Austria’, *Technovation*, 22 (3), pp. 147-159.

Kearns, K. P., Livingston, J., Scherer, S. & Mcshane, L. (2015) ‘Leadership skills as construed by nonprofit chief executives’, *Leadership & Organization Development Journal*, 36 (6), pp. 712-727.

Keizer, J. A., Dijkstra, L. & Halman, J. I. (2002) ‘Explaining innovative efforts of SMEs.: An exploratory survey among SMEs in the mechanical and electrical engineering sector in The Netherlands’, *Technovation*, 22 (1), pp. 1-13.
Kirschner, P., Van Vilsteren, P., Hummel, H. & Wigman, M. (1997) ‘The design of a study environment for acquiring academic and professional competence’, *Studies in Higher Education*, 22 (2), pp. 151-171.

Klazema, A. (2014) Objective vs. subjective writing: Understanding the difference [Online]. Available: https://blog.udemy.com/objective-vs-subjective/ (Accessed: 15 September 2015).

Knapp, J. (2016) *Sprint: How to solve big problems and test new ideas in just five days*. London: Bantam Press.

Korthagen, F. (1993) ‘Two modes of reflection’, *Teaching and Teacher Education*, 9 (3), pp. 317-326.

Kruger, C. & Cross, N. (2006) ‘Solution driven versus problem driven design: strategies and outcomes’, *Design Studies*, 27 (5), pp. 527-548.

Kumar, V. & Holloway, M. (2009) ‘How tangible is your strategy? How design thinking can turn your strategy into reality’, *Journal of Business Strategy*, 30 (2-3), pp. 50-56.

Landfield, A. W., Stefan, R. & Dempsey, D. (1990) ‘Single and Multiple Self Implications for Change Grids: Studies of Consistency’, *International Journal of Personal Construct Psychology*, 3 (4), pp. 423-436.

Lawson, B. & Dorst, K. (2009) *Design expertise.* Oxford: Elsevier.

Le Deist, F. D. & Winterton, J. (2005) ‘What is competence?’, *Human resource development international*, 8 (1), pp. 27-46.

Lee, Y. & Evans, D. M. (2012) ‘What drives organizations to employ design-driven approaches? A study of fast-moving consumer goods brand development’, *Design Management Journal*, 7 (1), pp. 74-88.

Liamputtong, P. (2009) *Qualitative research methods*. South Melbourne: Oxford University Press.

Liedtka, J., Rogerartin, M., Ogilvie, D. T. & Fraser, H. M. A. (2007) ‘The practice of breakthrough strategies by design’, *Journal of Business Strategy*, 28 (4), pp. 66-74.

Liedtke, J., Martin, R., Ogilvie, D. T. & Golsby−Smith, T. (2007) ‘The second road of thought: how design offers strategy a new toolkit’, *Journal of Business Strategy*, 28 (4), pp. 22-29.

Liu, S.-F., Lee, Y.-L., Lin, Y.-Z. & Tseng, C.F. (2013) ‘Applying quality function deployment in industrial design curriculum planning’, *International Journal of Technology and Design Education*, 23 (4), pp. 1147-1160.

Love, J. H. & Roper, S. (2009) ‘Organizing innovation: Complementarities between cross-functional teams’, *Technovation*, 29 (3), pp. 192-203.

Lu, C.C. (2015) ‘The relationship between student design cognition types and creative design outcomes’, *Design Studies*, 36, pp. 59-76.

Manzini, E. (2009) ‘New design knowledge’, *Design Studies*, 30 (1), pp. 4-12.

Maritz, A., De Waal, A., Buse, S., Herstatt, C., Lassen, A. & Maclachlan, R. (2014) ‘Innovation education programs: toward a conceptual framework’, European Journal of Innovation Management, 17 (2), pp. 166-182.

Mendoza, H. R. & Matyók, T. (2013) ‘Designing Student Citizenship: Internationalised Education in Transformative Disciplines’, *International Journal of Art & Design Education*, 32, pp. 215-225.

Miller, D., Greenwood, R. & Prakash, R. (2009) ‘What happened to organization theory?’, *Journal of Management Inquiry*, 18 (4), pp. 273-279.

Montealegre, R. (2002) ‘A process model of capability development: Lessons from the electronic commerce strategy at Bolsa de Valores de Guayaquil’, *Organization Science*, 13 (5), pp. 514-531.

Moore, R. A. & Aspegren, C. M. (2001) ‘Reflective conversations between two learners: Retrospective miscue analysis’, *Journal of Adolescent & Adult Literacy*, 44 (6), pp. 492-503.

Muckler, F. A. & Seven, S. A. (1992) ‘Selecting performance measures:" Objective" versus" subjective" measurement’, *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 34 (4), pp. 441-455.

Muhr, S. L., Gabriel, Y. & Linstead, S. (2014) ‘Luck of the draw? Serendipity, accident, chance and misfortune in organization and design’, Culture & Organization, 20 (4), pp. 334-341.

Nelson, H. & Stolterman, E. (2012) *The design way.* Massachusetts: MIT Press.

Niedderer, K. & Reilly, L. (2007) ‘New knowledge in the creative disciplines — proceedings of the first Experiential Knowledge Conference 2007’, *Journal of Visual Art Practice*, 6 (2), pp. 81-87.

Noble, C. H. (2011) ‘On elevating strategic design research’, *Journal of Product Innovation Management*, 28 (3), pp. 389-393.

Norman, D. A. (2010) ‘The research-Practice Gap: The need for translational developers’, I*nteractions*, 17 (4), pp. 9-12.

Nowacki, R. & Staniewski, M. W. (2012) ‘Innovation in the Management of SMEs in the Service Sector in Poland’, *Amfiteatru Economic*, 14, p. 755.

Nylund, P. A. & Raelin, J. D. (2015). ‘When feelings obscure reason: The impact of leaders' explicit and emotional knowledge transfer on shareholder reactions’, *The Leadership Quarterly*, 26 (4), pp. 532-542.

O’brien, W., Soibelman, L. & Elvin, G. (2003) ‘Collaborative design processes: an active-and reflective-learning course in multidisciplinary collaboration’, *Journal of Construction Education*, 8 (2), pp. 78-93.

Office of the United States Trade Representative. (2017) ‘Small Business’, [Online]. Available: https://ustr.gov/issue-areas/small-business (Accessed: 13 November 2017).

Okoli, C. & Pawlowski, S. D. (2004) ‘The Delphi method as a research tool: an example, design considerations and applications’, *Information & Management*, 42 (1), pp. 15-29.

Osland, J., Kolb, D. & Rubin, I. (2001) *Organizational behaviour: An experiential approach*. New Jersey: Prentice-Hall.

Ostergaard, K. J. & Summers, J. D. (2009) ‘Development of a systematic classification and taxonomy of collaborative design activities’, *Journal of Engineering Design*, 20 (1), pp. 57-81.

Palmer, I. & Dunford, R. (1996) ‘Conflicting uses of metaphors: Reconceptualizing their use in the field of organizational change’, *Academy of Management Review*, 21 (3), pp. 691-717.

Patterson, F., Ferguson, E., Lane, P., Farrell, K., Martlew, J. & Wells, A. (2000) ‘A competency model for general practice: implications for selection, training, and development’, *British Journal of General Practice*, 50 (452), pp. 188-193.

Patton, M. (2002) *Qualitative research and evaluation methods*. Thousand Oaks: Sage Publications.

Pickard, A. (2013) *Research methods in information*. London: Facet Publishing.

Porter, M. E. (2008) ‘The five competitive forces that shape strategy’, Harvard business review, 86 (1), pp. 25-40.

Posner, M. & Keele, S. (1973) ‘Skill learning’, In: Travers, R. (ed.) *Second handbook of research on teaching*. Chicago: Rand McNally.

Quayle, M. & Paterson, D. (1989) ‘Techniques for encouraging reflection in design’, *Journal of Architectural Education*, 42 (2), pp. 30-42.

Raney, C. & Jacoby, R. (2010) ‘Decisions by design: Stop deciding, Start designing’, *Rotman Magazine*, pp. 34-39.

Reason, P. & Bradbury, H. (2001) *Handbook of action research: Participative inquiry and practice*. London: Sage Publications.

Reber, A. (1989) ‘Implicit learning and tacit knowledge’, *Journal of Experimental Psychology: General*, 118 (3), pp. 219-235.

Reber, A. (1993) *Implicit learning and tacit knowledge: An essay on the cognitive unconscious*. New York: Oxford University Press.

Robson, C. (2011) *Real world research*. West Sussex:John Wiley & Sons.

Rodgers, P. A. & Clarkson, J. P. (1998) ‘An Investigation and Review of the Knowledge Needs of Designers in SMEs’, *The Design Journal*, 1 (3), pp. 16-29.

Rodolfa, E., Bent, R., Eisman, E., Nelson, P., Rehm, L. & Ritchie, P. (2005) ‘A Cube Model for Competency Development: Implications for Psychology Educators and Regulators’, *Professional Psychology: Research and Practice*, 36 (4), pp. 347-354.

Rolinska, A. (2011) On Dreyfus' model of acquisition [Online]. Available: http://idel11.pbworks.com/w/page/36248121/Dialogue%204 (Accessed: 17 April 2016).

Rubin, H. J. & Rubin, I. S. (2012) *Qualitative interviewing: The art of hearing*. London: SAGE Publications.

Rychen, D. & Saganik, L. (2001) *Key competencies for a successful life and a well functioning society*. Washington: Hogrefe & Huber Publishers.

Ryle, A. (1981) ‘Dyad grid dilemmas in patients and control subjects’, *British Journal of Medical Psychology*, 54 (4), pp. 353-358.

Salmon, P. (1976) ‘Grid measures with child subjects’, In Slater, P. (ed.) The measurement of interpersonal space by grid technique. London: John Wiley & Sons.

Schneiderman, D. & Freihoefer, K. (2013) 'The Prefabricated Interior Design Studio: An Exploration into the History and Sustainability of Interior Prefabrication', *International Journal of Art & Design Education*, 32, pp. 226-242.

Schram, S. F. (2004) 'Beyond paradigm: resisting the assimilation of phronetic social science', *Politics & Society*, 32 (3), pp. 417-433.

Schram, S. F. & Caterino, B. (2006) *Making political science matter: Debating knowledge, research and method*. New York: New York University Press.

Sennett, R. (2008) *The Craftsman*. London: Penguin Books.

Sennett, R. (2012) *Together: The rituals, pleasures and politics of co-operation.* London: Penguin Books.

Smith, K. M. (2013) 'Assessment as a Barrier in Developing Design Expertise: Interior Design Student Perceptions of Meanings and Sources of Grades', *International Journal of Art & Design Education*, 32, pp. 203-214.

Smith, K. M. (2015) 'Conditions influencing the development of design expertise: As identified in interior design student accounts', *Design Studies*, 36, pp. 77-98.

Solas, J. 1992. 'Investigating teacher and student thinking about the process of teaching and learning using autobiography and repertory grid', *Review of Educational Research*, 62 (2), pp. 205-225.

Souleles, N. 2013. 'The Evolution of Art and Design Pedagogies in England: Influences of the Past, Challenges for the Future', *International Journal of Art & Design Education*, 32, pp. 243-255.

Spencer, L. S (1993) *Competence at work*. New York: Wiley.

Sternberg, R. & Horvath, J. (1999) *Tacit knowledge in professional practice*. New Jersey: Lawrence Erlbaum Associates.

Suppiah, V. & Sandhu, M. S. (2011) 'Organisational culture's influence on tacit knowledge−sharing behaviour', *Journal of Knowledge Management*, 15 (3), pp. 462-477.

Svensson, P. (2003) 'Interdisciplinary design research', In: Laurel, B. (ed.) *Design research, methods and perspectives*. Boston: The MIT Press.

Tan, L. (2012) *Understanding the different roles of the desginer in design for social good. A study of design methodology in the DOTT 07 (Designs of the Time 2007) projects*. PhD thesis. Northumbria University.

Tashakkori, A. & Teddlie, C. (2003) *Handbook of Mixed Methods in Social & Behavioral Research*. London: Sage Publications.

Teece, D. J. (1977) 'Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-How', *The Economic Journal*, 87 (346), pp. 242-261.

Topalian, A. 2011. Major challenges for design leaders over the next decade. In: Cooper, R., Junginger, S. & Lockwood, T. (eds.) The handbook of design management. Oxford: Berg.

Tracey, M. W., Hutchinson, A. & Grzebyk, T. Q. (2014) 'Instructional designers as reflective practitioners: developing professional identity through reflection', *Educational Technology Research and Development,* 62 (3), pp. 315-334.

Turner, R. (2013) *Design Leadership : Securing the Strategic Value of Design*. Farnham: Ashgate Publishing Ltd.

Tushman, M. & O'reilly, C. (1997) *Winning through innovation: A practical guide to leading organisational change and renewal*. Boston: Harvard Business School Press.

Uline, C., Wilson, J. D. & Cordry, S. (2004). Reflective journals: A valuable tool for teacher preparation. *Education*, 124 (3), p. 456.

Valkenburg, R. & Dorst, K. (1998) 'The reflective practice of design teams',. *Design Studies*, 19 (3), pp. 249-271.

Van De Vrande, V., De Jong, J. P., Vanhaverbeke, W. & De Rochemont, M. (2009). 'Open innovation in SMEs: Trends, motives and management challenges', *Technovation*, 29, pp. 423-437.

Vargo, S. L., Maglio, P. P. & Akaka, M. A. (2008) 'On value and value co-creation: A service systems and service logic perspective', European Management Journal, 26 (3), pp. 145-152.

Vial, S. (2015) 'Philosophy applied to design: A design research teaching method', *Design Studies*, 37 (1), pp. 59-66.

Visser, W. (1995) ‘Use of episodic knowledge and information in design problem solving’, *Design Studies,* 16 (2), pp. 171-187.

Von Stamm, B. (2008) *Managing innovation, design and creativity*. West Sussex: John Wiley & Sons.

Wang, J.-K., Ashleigh, M. & Meyer, E. (2006) ‘Knowledge sharing and team trustworthiness: its all about social ties!’, *Knowledge Management Research & Practice*, 4 (3), pp. 175-186.

Williams, A., Cooper, R., Evans, M. & Sun, Q. (2010) ‘2020 vision - The UK design industry 10 years on: Implications for design businesses of the future’, In: Inns, T. (ed.) *Designing for the 21st century: Interdisciplinary methods and findings*. Surry: Gower Publishing Limited.

Wong, W. & Radcliffe, D. F. (2000) ‘The tacit nature of design knowledge’, *Technology Analysis & Strategic Management*, 12 (4), pp. 493-512.

Wrigley, C. & Bucolo, S. (2012) ‘New organisational leadership capabilities: transitional engineer the new design?’, In: Bohemia, E., Liedtka, J. & Reiple, A. (ed.) *Leading innovation through design: Proceedings of the DMI 2012 international research conference*. Boston, Massachussetts.

Yang, C., Liu, Z., Wang, H. & Shen, J. (2013) ‘Reusing design knowledge based on design cases and knowledge map’,. *International Journal of Technology and Design Education*, 23 (3), pp. 1063-1077.

Yeung, A. K. & Ready, D. A. (1995) ‘Developing leadership capabilities of global corporations: A comparative study in eight nations’, *Human Resource Management*, 34 (4), pp. 529-547.

Yoo, Y., Boland Jr, R. J. & Lyytinen, K. (2006) ‘From organization design to organization designing’, *Organization Science*, 17 (2), pp. 215-229.

Yousuf, M. I. (2007) ‘The Delphi technique’, *Essays in Education*, 20, pp. 80-89.

Zaleznik, A. (1997) ‘Managers and leaders: Are they different?’, *Harvard Business Review*, 55, pp. 67-78.

Zerfass, A. (2005) ‘Innovation readiness’, *Innovation Journalism*, 2 (8), pp. 1-27.

Zuber−Skenitt, O. (1993) ‘Improving learning and teaching through action learning and action research’, *Higher Education Research and Development*, 12 (1), pp. 45-58.